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View Looking Forward, Showing One of the Steel Decks. The Over-all Length is 950 Feet.

LAUNCH OF THE LATEST GIANT STEAMSHIP.—[See page 232.]

A Self-starting Single Phase Induction Motor—I*

Directions for Its Construction

By Charles F. Fraasa, Jr.

CONSTRUCTION OF STATOR, FRAME AND BEARING END PLATES.

THE accompanying drawings illustrate the construction of a one eighth horse-power self-starting single-phase induction motor. The motor was designed to operate on 110 volts at 60 cycles. Running on 60-cycle alternating current, the synchronous speed is about 1,800 revolutions per minute, but the full-load speed will be somewhere about 1,750 revolutions per minute.

The motor is of the purely induction type, operating on the induction principle. There are no brushes, commutator, or insulated windings on the rotating parts to get out of order. The motor is simple electrically and mechanically, but to build a satisfactory motor of this type, requires great care in the design, and accuracy in the mechanical construction.

The induction motor consists of two essential parts, namely, a primary and a secondary winding. The primary is usually stationary and is known as the stator, while the secondary rotates, and is known as the rotor. The line current is led into the primary winding, producing a magnetic field. This magnetic field induces a current in the secondary, and the secondary induced current in turn produces a magnetic field which reacts upon the primary field, tending to rotate the secondary. It is necessary, however, that there be a relative motion of the magnetic field, in order that the current may be induced in the secondary by the conductors cutting the magnetic field of the primary winding.

In the two-phase motor, this motion of the field is produced by the difference in the phase of the two currents and by a suitable arrangement of the winding. In the four-pole motor, the four coils of each phase span one quarter of the circumference of the stator. The coils of the two phases lap over one another for one eighth of a circumference; that is, the conductors of the coils of one phase are in the middle of the coils of the other phase. When the current is at its maximum in phase one, it is at its minimum or zero in phase two. At this instant there are produced four magnetic poles of maximum intensity. An instant later the current in phase one is diminishing, while in phase two it gradually assumes value. The result is a diminution of the strength of the four original magnetic poles and the establishment of four new poles between the original poles. As the original magnetic poles decrease and the new magnetic poles increase in value, the magnetic field seems to gradually shift from its original position to a new position midway between the original poles. In the succeeding cycles of the current, the poles continue to shift, making complete revolutions around the stator core.

In the single-phase motor, to produce the same effect a different procedure must be adopted. It is necessary in starting to split the single phase up into two phases, one lagging behind the other. The same winding is used as in the two-phase motor, but one is used as a main or running winding, and the other as a phase or starting winding. The phase winding is composed of smaller wire, having a greater resistance and fewer turns than the main winding. The difference in resistance and inductance between the two windings causes a lagging of current in one of the windings, producing a slight imitation of the two-phase rotating field. The phase coil is used only in starting, and when the motor is up to speed, should be cut out of circuit.

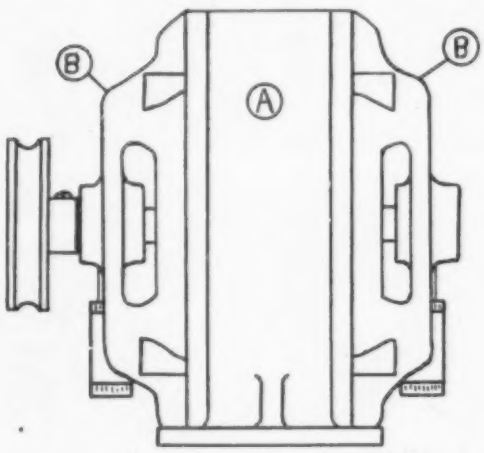
The induction motor is virtually a transformer, the stator winding being the primary, and the rotor winding being the secondary. In the transformer, to get good regulation and power factor, the primary and secondary coils are placed as close together as possible, and air gaps are eliminated. In the induction motor this is also essential, though the coils must be separated to allow for the rotation of the rotor. In a motor of this size, the air gap should be very small, but sufficient to give a mechanical clearance.

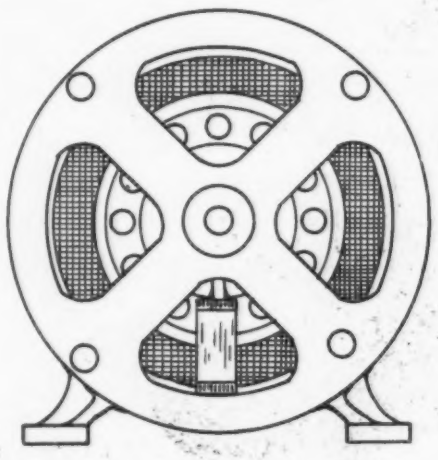
As the rotor winding is short circuited upon itself, it is not necessary that it be of the wound type, but may be composed of copper bars short-circuited to copper end rings. A rotor constructed in this way is very rugged and practically indestructible.

Fig. 1 illustrates the completed machine. Castings will be required for the stator frame *A*, and for the endplates *B*. The stator is mounted in the frame, between the two endplates, and is composed of a number of laminæ having slots punched around their periphery to receive the stator winding. The rotor is of the bar-wound type having copper bars inserted through holes drilled around the core near the periphery. As none of the parts of this motor are of standard manufacture, it will be necessary for the builder to prepare his own stator and rotor laminæ. It is not assumed that the reader owns or has access to any special step-by-step disk-notching press, so data are given for punching these laminæ on any small hand or power punch that may be available. The rotor is of simple construction, the holes for the bars being merely drilled around the periphery.

The stator core, dimensioned in Fig. 2, is composed of enough sheets of No. 29 sheet steel to make a thickness of 1¾ inches when tightly compressed. For punching the slots in the stator disks, the device shown in Fig. 3 should be constructed. This consists of a mandrel *A* on which the disks *B* are supported and rotated when punching the slots, and a die *C*. The disk *D* is mounted on the mandrel with the laminæ, and has notches around its periphery, which are engaged by the stop *E*, locating the slots. The whole device is fastened to the frame of a small notching punch (such as are usually found around any machine shop) by means of the screws *F*.

The strip *G*, Fig. 3, dimensioned at *A*, Fig. 5, is a piece of 1/16-inch sheet iron. The holes *B* and *C* are located with reference to Fig. 2, so that the die will be brought in the proper position for punching the slots. The mandrel *D*, Fig. 5, is turned from a piece of iron or steel rod, and threaded on both ends to receive the ¼-inch nut *I*, and the part *H*, Fig. 3. The piece *H* is turned from ½-inch rod and tapped to fit the mandrel. A 1/8-inch rod is inserted to enable it to be rotated. The disk *E*, Fig. 5, which locates the slots is cut from sheet brass about





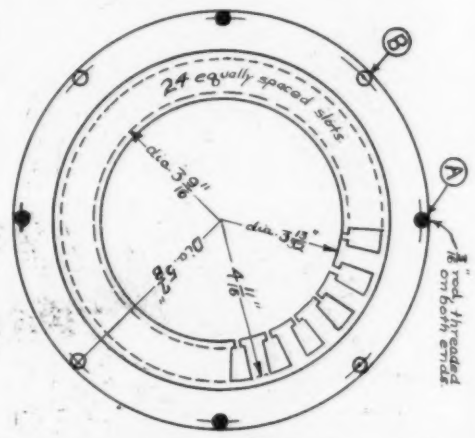


Fig. 1.—External View of the Completed Motor.

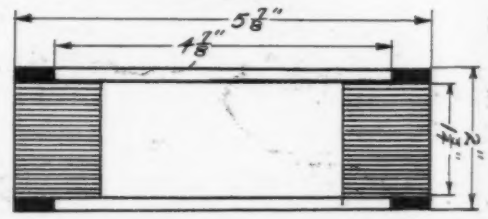


Fig. 2.—The Stator Core.

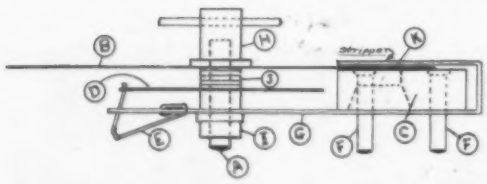


Fig. 3.—Device for Punching Slots in the Stator Disk.

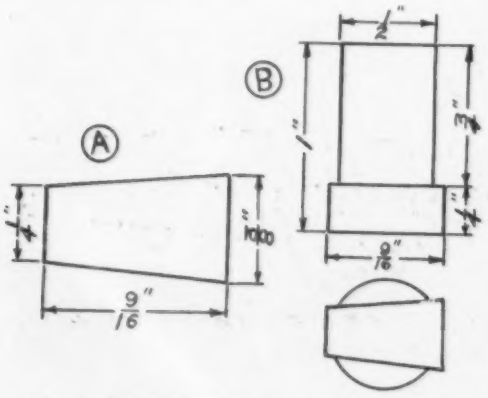


Fig. 4.—Detail Drawing Showing Dimensions.

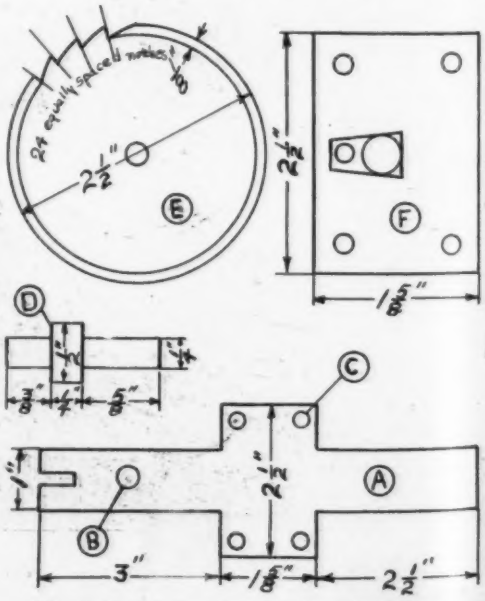


Fig. 5.—Detail Drawing Showing Dimensions.

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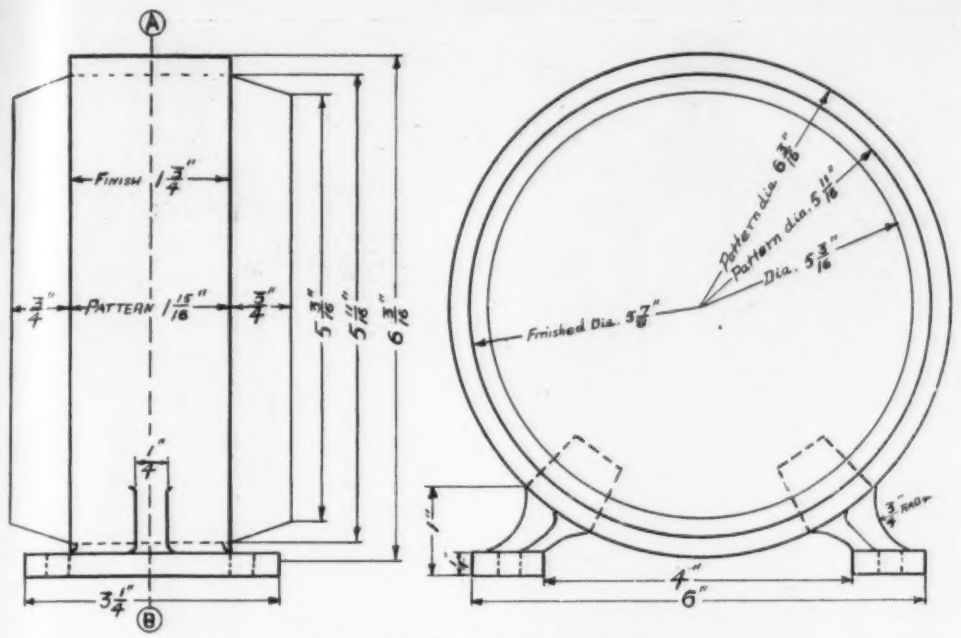


Fig. 6.—Pattern for the Stator Frame.

1/16 or 1/32-inch thick. The illustration shows how the notches are cut in it. With the notches cut in this way, the disk can rotate only in one direction, acting as a stop when turned in the other direction.

The die *F* is made of a piece of annealed steel, which any dealer will provide if told what it is to be used for. A ¼-inch and 5/16-inch hole are drilled in it as shown, and the slot shaped out with a small file to the dimensions *A* given in Fig. 4. The slot hole should taper out in all directions on the under side of the die-plate to allow the punching to fall out. The four holes in the corners of the die-plate are ¼-inch holes, through which pass screws to hold the die to the punch frame. Having made the slot hole, the die-plate should be tempered. To harden it, the steel is heated to a bright red, and dipped in oil or luke warm water; but not cold water, for this would make it very brittle. Draw the temper in the flame of a Bunsen burner, wiping the steel frequently with an oily rag during the process. If the reader is not familiar with the handling of tool steel it would be better to have this done by some one having experience.

When the parts are constructed, insert the mandrel *A* in the hole in the strip *G*, put a thin washer over the projecting end, and turn on the bottom nut *I*. Then put on the disk *D*, and enough washers *J*, to bring the laminæ disk *B* to the surface of the surface of the die. The die is then put in place, when the whole may be fastened to the punch frame by means of the four screws *F*. Then bend the end *K* of the strip *G* over the die to form a stripper. The space between the stripper and the die-plate should be about 1/16 of an inch. A hole should be made in the stripper having the same shape as the punch but slightly larger so as to freely admit it. When the laminæ disk has been put in place, put on a thin washer and turn on the nut *H*. We are ready to punch the slots.

Probably these dimensions will not be satisfactory for the punch to which the reader has access. The device should then be arranged especially for it. The data given are merely to show how the punching was done by the writer.

The punch is shown at *B*, Fig. 4. This is also made of annealed tool steel, which should be bought in the most convenient shape, and machined to proper dimensions. The one end is to fit in the hole in the punch plunger, which in the writer's instance was ½ inch in diameter; the other end is to make a snug fit in the die-plate slot. At *A* is given the dimension of the end of the punch and of the die slot. The greatest care should be exercised in this work to have all parts and dimensions accurate. The punch is hardened as was the die-plate.

The construction of the stator laminæ is as follows: Enough 6¼-inch diameter disks are cut from some No. 29 sheet steel to make a stack 1¾ inches thick when tightly compressed. Clamp these disks down on the drill press with a piece of 1/8-inch sheet iron on each side, and drill a ¼-inch hole through the center of the stack. The eight holes *A* and *B*, Fig. 2, are drilled with a 3/16-inch drill. The four alternate holes *A* in the sheet-iron plates are to be counter sunk so that when the rods which hold the laminæ together are riveted the ends will be flush with the surface. The disks are mounted one at a time on the mandrel of the punching device. Then turn the disk until the notch on the disk *D* is engaged by the stop *E* and punch the first slot. Succeeding slots are located by turning the disk ahead one notch and back until the stop is engaged.

When the disks are all punched, shellac or japan one side of each disk, and assemble them on the eight 3/16-inch rods *A* and *B* with one of the thin pieces of sheet iron used when drilling the holes on each end. These rods should be about 4½ inches long and threaded on one end for a distance of 1 1/8 inches, and on the other for a distance of 1 5/8 inches. Turn a nut very tightly on each end of the rods to clamp the whole stator together. These rods will project about 1½ inches on one side of the stator. The stator is then fastened to the lathe face-plate by inserting the long ends of the rods in the holes in the face-plate, and turning on nuts to bind it there. When it is centered accurately, cut out the 1/8-inch sheet iron covering the slot holes, boring to a diameter of 4 7/8 inches. The tool may then be set for boring out the stator. To prevent the tool tearing the teeth, the slots should each have a piece of wood of the same shape as the slot forced in them. Then bore to a diameter of 3 13/32 inches. The outside of the stator is turned down to 5 7/8 inches in diameter. The stator will now appear as in Fig. 2. The nuts on the alternate rods *B* are removed, and the rods sawed off and riveted down. Since the holes for these rods were counter sunk the rods may be riveted flush with the surface. The remaining four rods should be cut off so that they project for a distance of 1 1/8 inches on each end.

The pattern for the stator frame is detailed in Fig. 6. Owing to the base lugs it is necessary to make it in two parts. The dividing line is the line *A-B*. The pattern halves are each constructed of a number of pieces of ¼-inch white pine, glued together. These are glued to a wooden face-plate, and turned to the dimensions given in the drawings. A core print is turned on each end as dimensioned. The two parts of the pattern are secured together by means of four dowel pins. The base lugs, made in two parts, are cut from white pine and glued in the halves of the pattern as indicated by the dotted lines.

The end plates are exactly alike, so only one pattern need be made. The pattern, Fig. 7, is built up of ¼ inch white pine and turned inside and out. The windows are cut out with a coping saw. Four pieces of 5/8-inch dowel *A* each ¾ inch long are then glued in holes drilled at the four equidistant points as shown. Then turn two core prints *A*, Fig. 8, and glue them in holes drilled in the center of the bearing hub. Two bearing castings will be required.

All sharp corners of the patterns should be well rounded out with fillet. When the patterns are finished, sandpaper well with No. 0 paper and apply a first coat of shellac. When dry, sandpaper again until smooth, as the first coat of shellac raises the gum and roughens the surface of the wood. Apply a second coat and repeat until a smooth surface is obtained. At least three coats will be required; on end wood, about four.

The castings are to be cleaned with an emery wheel, or a file and emery cloth. All rough surfaces on the outside of the castings are to be ground smooth. The base lugs of the stator frame should be ground or planed to shape. Then chuck the casting and bore the inside to a diameter of 5 7/8 inches and face off both ends, making the width 1¾ inches. Each base lug has a hole drilled in it for the bolts which hold the motor frame down.

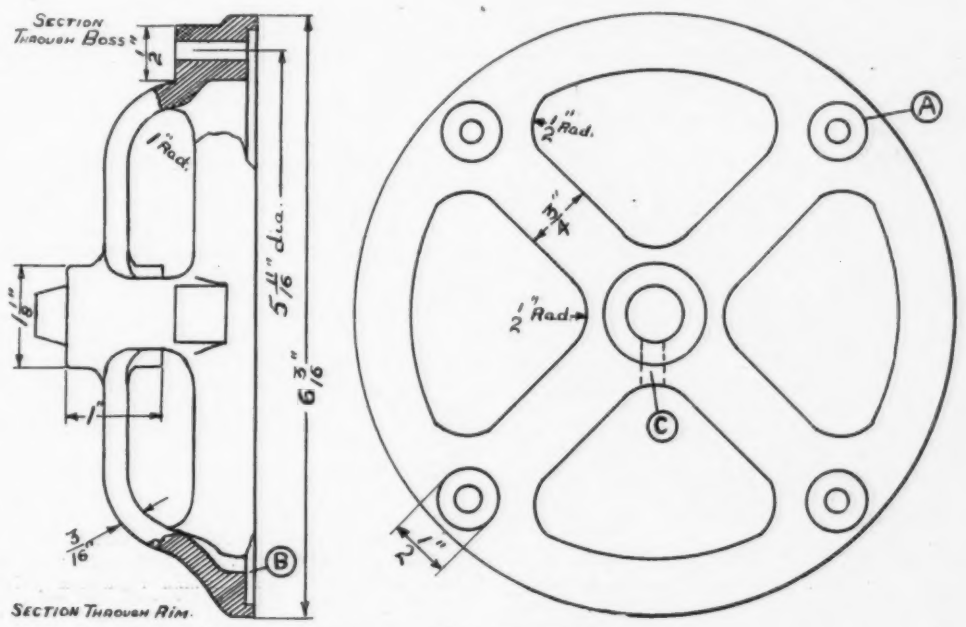


Fig. 7.—Pattern for End Plates.

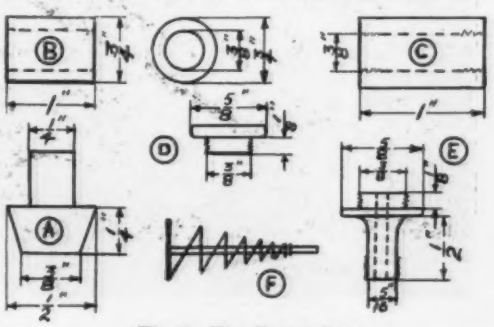


Fig. 8.—The Grease Cup.

Mount the bearing-end plates on a mandrel and face the bearing hubs. Bore out the bearings to ¾ inches for the bearing bushings. Then finish the surface of the bosses *A*, Fig. 7, and turn the recess *B* 1/8 inch deep and 5 7/8 inches in diameter. The bosses *A* should have 3/16-inch holes drilled in them for the rods which bolt it to the stator. The hole *C* for the grease cup should be drilled with a No. 14 drill and tapped 20 threads.

The bearing bushing *B* is made of hard brass or phosphor bronze. The inside should be accurately bored to 3/8 inch in diameter. Then mount the bushing on a mandrel and turn the outside to ¾ inches in diameter. The bushing should be forced in the end-plate, and should fit snugly. When the bushing has been driven in place, ream with a 3/8-inch reamer.

The grease cup is composed of a piece of brass tube *C*, Fig. 8, one inch long, having an internal diameter of 3/8 inch. The ends are threaded internally for a distance of about 3/16 inch. The caps *D* and *E* are turned from brass, threaded to screw into the ends of the tube. The cap *E* has a 1/8-inch hole bored through it as indicated by the dotted lines. The grease is fed to the bearing by a 1/8-inch wick, which has a piece of brass spring wire coiled about it as shown at *F* to force it against the shaft. The wick passes through a 1/8-inch hole in the bearing bushing.

To be continued.

A Wizard of the Tungus Tribe of Siberia.

The Back of the Shaman's Costume is Highly Ornamented

A Tungus Shaman in His Full Uniform

Siberian Shamans

Among the curious and little known primitive dwellers of northeastern Asia, are the Shamans, so-called supernatural and "knowing ones." They play an important rôle in the life of the native people. The accompanying photographs show a typical group of these "inspired prophets" of several of the leading nomadic reindeer tribes of Siberia, namely, the Yakut, Koryak, Tungus and Chukchi, dressed in their grotesque costumes. These wizards are able to work various spells, drive away by word of mouth or by means of drum-beating the numerous evil spirits who, according to their belief, walk invisibly over the earth, producing diseases and all sorts of misfortune. The leading and essential part of the Shamans' paraphernalia is a drum, which is oval-shaped and covered with reindeer skin, having inside a number of jingling bells. The men and women Shamans of the Yakut tribe have the most remarkable and fantastic costume of all, as the entire back of their garments is sewn with bells, amulets, and various clanging pieces of metal, which they strike and rattle during their magic incantations and performances. The occupation of the Shaman is due to the wide-spread belief in the presence and existence of various evil and dangerous spirits that are hostile to man.

The conception of evil spirits (kelat), wandering unseen about the earth, is extensively developed, all misfortunes and maladies and death, are ascribed to them. They come from under the ground, or from the extreme limits of the country, for the sole purpose of harming men, and having accomplished their purpose they pass on. Protection against these evil spirits can be gained only from right-minded Shamans, who can foretell their attacks and advise measures for rendering them ineffective.

The kelat, when attacking man, first tries to get his soul, and eat it. Every man has from five to six souls, or even more. These souls are very small—not larger than a gnat. Everybody can lose one or even two of these without endangering his health, but if he loses too many, illness ensues. On the other hand the Shaman can cure a man who has lost all his souls by blowing into him some part of his own spirit or by replacing the soul with any of the kelat dependent on himself. Besides those pertaining to the whole body, there are special limb-souls for hands and feet. Occasionally these latter may be lost. Then the corresponding limb begins to ache, but the limb-souls stay on the spot where they were lost. A Shaman, however, can call them to himself, and can make them fly from the open country to the house of the Shaman who summons them. One or all of the souls of the whole person may be stolen by the kelat, then the man becomes sick and sometimes dies. The Shaman can find and restore the missing souls, he can blow into the person a part of his breath to become a soul, or he may give him one of his servant-kelat to replace the missing soul. The souls are very small. When passing by they produce a sound like a humming of a bee or the drumming of a beetle.

The Shamans are able to work various spells, by word of mouth or by means of objects. They also create special charms and send them to persons "subject to anger" that is destined to incur the anger of Shamans. The charms may assume various shapes, and even change their form, at the will of the sender. They appear as inanimate objects, animals, or men. When caught and disarmed they will serve their captor, or, if repulsed, will come back of their own accord and strike their sender. The arrangement of festivals and religious ceremonies, and the preparation of guardians and amulets, incantations, and similar things pertaining to the family cult, are attended to by each family separately. The eldest member of the family usually acts as the priest of the family cult, while some female member acquires particular skill in the art of beating the drum and singing, and familiarizes herself with the formulæ of prayers and incantations. All this combined may be called "family shamanism" as distinguished from "professional shamanism."

Family drums are considered the most sacred objects of the household, they descend by inheritance and must not be given to strangers, they are supposed to protect the well-being of the family, and play a part in all rites and feasts and on all holidays. The professional Shaman is a man inspired by a particular kind of guardian spirits by the help of which he treats patients, struggles with other Shamans, and also causes injury to his enemies. Thus the activity of the professional Shaman is outside the limits of the family cult, and a skilful Shaman enjoys a popularity for hundreds of miles.

Shamans possessing the art of ventriloquism are endowed with particular power, for the Koryak believe that the voices which seem to emanate not from the Shaman but from various parts of the house are the voices of the spirits called up by the Shaman. Among the most remarkable are the so-called "transformed" Shamans. These, according to the Koryak and Chukchi belief, have changed their sex by order of the spirits. The young man doomed to sexual transformation receives a message to that effect from his spirits, and must at once don women's clothes and acquire a woman's voice, begin to sew, cook and do other kinds of women's housework, and forget his former masculine knowledge. Such cases, however, are not numerous. The Chukchi Shamans use the common family drum in giving an exhibition of their skill. They perform their tasks in utter darkness, in the inner sleeping room of the tent.

A Shaman will sing and drum without sign of fatigue for several hours, as if he were buoyed up by the spirits who sang and performed in his place. In all rites, yearly feasts and ceremonies, Shamans play an important part.

Group of Siberian Shamans

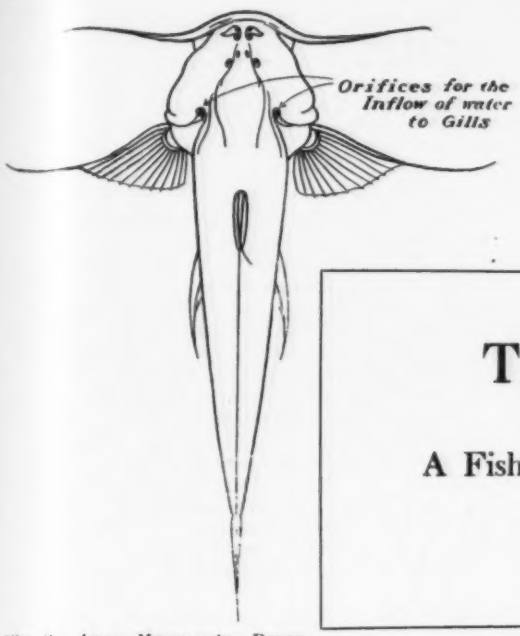


Fig. 2.—*Argus Marmoratus* Regan; Dorfal View.

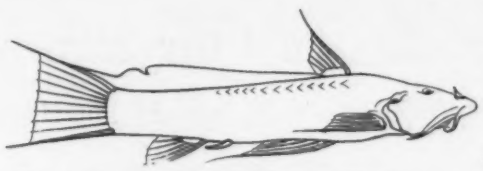


Fig. 1.—*Argus Marmoratus* Regan; Side View.

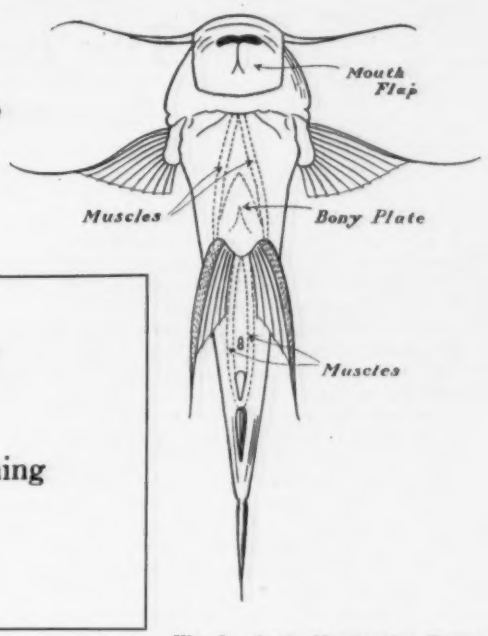


Fig. 3.—*Argus Marmoratus* Regan; Ventral View.

The Climbing Catfish*

A Fish That Prefers Climbing to Swimming

By R. D. O. Johnson

THE creeks and rivers of the Andes Mountains in the Republic of Colombia, South America, are torrential in character. The great majority of them are but a succession of falls, cascades, pot-holes and short "riffles." The rainfall in the mountains is heavy and the rock underlying the stream beds is schistose in character and comparatively soft. The rate of erosion is exceedingly rapid, yet the grade lines of these streams stand at high angles. This unstable condition seems to be due to the elevation of the Andes during a late geological period. The heavy rainfall, at times amounting to four or five inches within a few hours, produces floods of immense volume. These go charging down the canyons with fearful fury, and at times it would appear that nothing could withstand their sweeping energy. Yet these turbulent waters are the habitat of fishes so wonderfully adapted to their surroundings they are able to grow and to multiply in great numbers.

In external appearance they resemble the catfish or horned pout of the north. The skin is smooth and scaleless. The color is a dark mottled gray shading into a slightly yellowish tint on the posterior parts. They rarely attain a length greater than twelve inches. As an article of food they are esteemed by the natives and are well known by the local name "Capitan." They have lately been described by C. Tate Regan as *Argus marmoratus*.†

Under usual conditions they are clumsy and awkward swimmers, wriggling through the water like tadpoles, but as creepers and climbers they are without rival in the fish family. The mouth is small, but is surrounded by a broad, soft, rubber-like flap, very thin and flexible at the edges (Fig. 3). It is a sucker mouth and the entire mechanism is so perfectly adapted to the needs of the fish that it finds no difficulty in firmly attaching itself to any convenient object. It is this ability to make a quick anchorage that enables the fish to stay at home when nature seems bent upon sweeping the canyons and water-courses clear of everything movable.

If, however, these fish were able only to keep themselves from being washed out in flood times, they would be insufficiently equipped to maintain an existence in these mountain streams. If they depended upon their imperfect swimming alone as a means of locomotion, whatever migratory movement they attempted would inevitably have to be made in a down-stream direction. The final result would be the same as though they were unprovided with a means of anchoring themselves at will. But they are equipped with another and very efficient apparatus for locomotion. The flat sucker mouth is half of the mechanism; the other half is located on the belly. Under the skin of the ventral side, just behind a line joining the pectoral fins, there is a triangular bony plate to which are attached the ventral fins (Fig. 2). The main anterior ribs of these fins are broad and flattened, and the flat surfaces are thickly studded with small, sharp teeth pointing backward. The triangular plate and its attached fins are free to move in a longitudinal direction through a distance equal to about one sixth of the length of the fish. This movement is accomplished by means of four muscles in two pairs attached to the plate; the anterior pair extending from their attachments on each side of the plate forward to the middle point on the bony arch just below the gill openings; the posterior pair extending from an attachment at the center of the posterior edge of the plate to the anal fin. It is evident that the fish is able to create a suction pressure in the region of the plate, though how this is accomplished is not apparent from the structure.

By means of the alternate action of the mouth and of this curious apparatus, the fish is able to creep against a current that would baffle its efforts entirely, if it relied alone upon its fins and tail. When it is engaged in creeping or in sticking fast to some object, the sucker mouth necessarily is closed. It is evident that the gills must be supplied with the life-maintaining flow of water through some other avenue. At the upper extremity of each gill slit there is an orifice provided with a valve opening inward (Figs. 1 and 2). During the diastole of the gill covers, the water flows inward through the orifices and is expelled through the gill slits during the systole.

On clear sunshiny days, these fish may be seen in the depths of the clear water hitching themselves along over the surfaces of rocks, occasionally swimming short distances in the more quiescent places, but seeming to depend for locomotion primarily upon their creeping mechanism. They are to be found in all parts of these mountain streams, from the most slender tributaries to the foot of the mountains. It is evident from this fact that they are able to travel up stream. They are too sluggish in movement and are provided with a swimming apparatus altogether too inefficient to enable them to dash up the high and frothy falls.

At one time, the writer had occasion to divert the water of a small mountain stream so that access could be gained to a deep pot-hole from which the water, rock and gravel were subsequently removed. This pot-hole was twenty-two feet deep, nearly circular in horizontal cross-section and it varied in diameter from six to ten feet. Generally, the sides approached the vertical and in some parts inclined inward. When the water had been lowered to within four feet of the bottom, the remaining water was seen to contain a large number of "capitanes." They were greatly excited and distressed and were swimming and creeping about in all directions. A small stream of water in a thin film ran down one side of the pot-hole from a leak in the dam above. Several fish, after nosing around the edge of the water, discovered this small inflowing stream and started to creep up in it, but becoming frightened by the movements of the working men near, dropped back. When work was stopped for the noon hour, four of the smaller fish started up, following the thin stream of water. The water ran over their noses, down their backs and trickled off their tails in small streams. They would hitch themselves up rapidly for the distance of a foot or so and remain quiet for a minute or two; then another foot and another rest. In half an hour, the four had reached the water in the pool at the foot of the dam above. In making the ascent, they were obliged to pass a part of the wall, about two feet in length, that inclined inward at an angle of about 30 degrees from the vertical. When they reached this overhanging part, in no observable manner did they change their tactics, but they ascended it as rapidly and safely, and apparently with no more effort than the other portion of the wall. During the afternoon, several more of the fish climbed out. A large number were in the water at the bottom of the hole when work was suspended for the evening. In the morning not a fish remained.

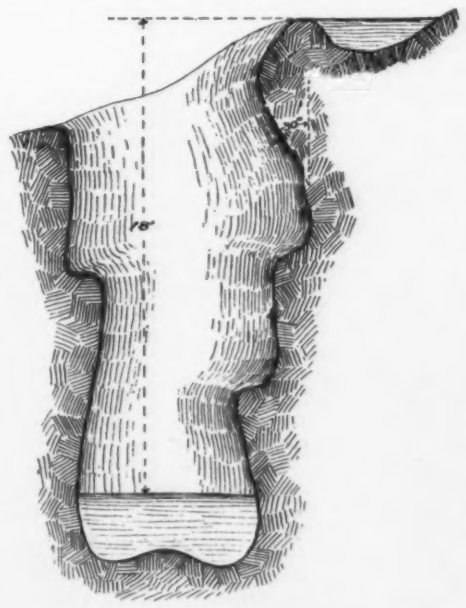


Fig. 4.—Section of a Pot-Hole, Twenty-two Feet Deep, in Santa Rita Creek, Colombia, Showing "Capitanes" Ascending Its Rocky Walls.

For the greater part, the path followed by the fish in making their ascent lay over smooth, water-worn surfaces free from any coating of vegetable matter. The upper part, however, was covered by a thin film of an alga-like growth that may have served for the engagement of the sharp-pointed teeth on the movable ventral fins. The total vertical distance through which the fish climbed measured eighteen feet. When undisturbed, they covered the distance without a slip or fall. The water, diverted around this pot-hole, flowed through a large pipe and fell from the end upon the steeply inclined water-worn rock at the side of the channel below. A day or two after the water had thus been diverted, a dozen or more of these fish were observed to be clinging to the rock at the foot of the fall at the end of the pipe. They were evidently on their way up stream, but had encountered an artificial condition that interrupted their further progress. They were nosing about in search of a small stream or film of water sufficient to keep their gills wet and to lead them to the main body of water above. As there was no such stream, their further progress was prevented. They made no observed attempt to swim up the fall, but confined their efforts to making short excursions up the rock above the water. Failing to find any leading stream, they crept back.

They deposit their eggs in the deepest pot-holes and attach them individually to the under sides of large rocks.

The group of catfishes holds a puzzling place among fishes. There can be no doubt that it represents one of the ancient groups of bony fishes, but their exact descent still remains an open question. They may have been derived through a long series of specializations from a carp-like ancestor.

* Reproduced from the Annals of the New York Academy of Sciences.

† Trans. Zoological Society of London, xvii., p. 314. 1904.

The Benefits of Our Patent System

The Difference Between Monopoly and Patent Protection

By Jesse B. Fay

[*The following is an abstract of an opinion prepared by a well-known patent lawyer as an appendix to the report submitted to the Board of Directors of the Cleveland Chamber of Commerce by its Committee on Patent Laws and Administration.*—EDITOR.]

FOR several years there has been a great deal of interest in the subject of trusts and monopolies brought about by enormous combinations of capital, and latterly this interest has extended to monopolies under patents. This has been stimulated by the recent decision of the U. S. Supreme Court in the case of Henry v. Dick, where the Court divided by a vote of four to three on the legality of license restrictions in connection with a patented article. The comments of the newspapers on this case evidenced a grave misconception of what a patent really is, as well as of the theory on which the U. S. patent law is founded, and following this a flood of new bills relating to patents were introduced into the U. S. Senate and House of Representatives, and it became apparent that even our national law-makers had little or no conception of the principles and theory of the patent law.

This is not so surprising when it is known that the Committee on Patents of the present House of Representatives is made up of fourteen members, six of whom are from southern States having substantially no manufacturing interests, and two others from northern States which are not known as manufacturing States.

The sub-committee, having charge of the principal bill relating to the revision of the patent laws, is made up of six members, four of them, including the chairman, coming from extreme southern States, the remaining two from Illinois and Wisconsin, and the southern members have all through the hearings of the sub-committee appeared the most active members.

The chairman of the committee is from Arkansas, and his attitude toward patents will be clear from the following sentence found in his report to the House of Representatives on the substitute patent bill bearing his name:

"A patent is so dangerous an instrument that its mere use in such a combination (meaning a combination of large capital that had rendered itself amenable to the Sherman Act) should be held conclusive evidence of the unreasonableness of the restraint exercised."

All this agitation produced such a flood of questions and conjectures regarding patents, that I was impressed to try to analyze the situation for my own satisfaction, and in doing so I drew up a series of illustrations in the attempt to make clear the distinction between the patent monopoly and other monopolies, and this paper is the result.

PATENT MONOPOLY COMPARED WITH OTHER MONOPOLIES.

There is a broad distinction between monopolies which occur through combining a plurality of industrial enterprises into one combination, which we usually refer to as trusts, and the monopoly granted under our patent laws.

We will assume that there are but twenty steel mills in the United States capable of making steel rails, and that steel rails have been sold at an average price of $20 a ton during a period of years. A combination is effected between these twenty mills, whereby they become one corporation, subject to the control of but one board of directors, and as soon as this is accomplished, they raise the price of steel rails, and uniformly maintain that price at $28 a ton. They have an absolute monopoly in the making and selling of steel rails. They control a large proportion of the entire supply of ore. They own steamship lines and railroad lines. Steel rails are a necessity under modern conditions. The railroads must buy steel rails, and these steel rails are paid for ultimately, not by the railroads themselves, but by the hundreds and millions of passengers over these roads, and the hundreds and thousands of manufacturers and merchants who use these railroads as a means of shipment of their products. If the rise in price is all net profit, as it may be under these circumstances, if none is put into increase of wages or improvement of goods, then, under these circumstances, every man in this country is injured by the rise in price. He is made to pay more for the same service, for the same article, than he paid before under the old conditions of competition. This rise in price may be so infinitesimal per capita to the ninety million people of this country, that no one feels it, but nevertheless it is there, and is paid for in proportion to the use which the individual makes of the railroads; and practically every individual in this country, under these circumstances, in one way or another is affected by this increased price.

We will assume that there are in the United States but ten manufacturers of shoes, and the average selling price of shoes under the conditions of competition is $3 a pair. These ten manufacturers of shoes, one after the other, are approached by a syndicate which purchases their factories, combines them into one organization, gets control so far as may be of the raw product, leather, and other things, and raises the price so that shoes of the same quality which before sold for $3 a pair now sell for $3.50 a pair, and every person in the United States who wears ready-made shoes thereby pays an increased toll to the manufacturer of these shoes.

Before the subways were built in New York city, they had surface cars and elevated cars by which to transport the people to and from their offices, factories and homes. Certain far-sighted people, with money at their command, approached the city authorities and said:

"If you will give us a monopoly for fifty years, and loan to us the credit of the city whereby to float our bonds, we will undertake to bore subways under the city, and carry passengers more quickly and expeditiously than it is now possible to carry them by means of surface and elevated roads, but we must have a monopoly on this, in the streets in which we put our subways, for the period of fifty years. At the end of that time you may take over these subways, they become yours without further payment." It was thought wise, and it has proved wise that this should be done. The subway company is allowed to charge a certain price, that is, a certain toll or royalty for carrying these passengers. Here, notwithstanding the price may be too high or too low, the people do not suffer the injury which is suffered by the people under the conditions of the first two illustrations, for in this case all the opportunities and avenues of transportation which were open to the people before, namely, the surface cars and the elevated cars, are still open to them for use, and also in this case the charge for transportation is no higher than it was by the older, cruder methods of transportation so that the people are benefited by this monopoly, even though it may extend beyond an average life. This monopoly thus created is certainly for the benefit of the people, and at the end of the monopoly, which is fifty years, the subways become the property of the city, and the city may lease these subways on the best terms it is capable of effecting and people may thereafter be transported for a sum possibly one half or one third of the present five-cent toll, tariff or royalty.

After these original subways had been established in New York city, another syndicate was formed, and this syndicate came to the city authorities, and said: "We will establish subways, starting in New Jersey, boring under the river, to New York city, and passing northward in New York city, to distribute people between New York and New Jersey. We have found, by observing the old subways, that we can still make money by this new route, notwithstanding the enormous cost we must be put to, even though we offer the city better terms than the old subway offered the city, and if you will permit us to put our money at risk, we will open up a new avenue of transportation, and we will do this, provided we have the exclusive monopoly on the route we pick out, for only twenty-five years, which is one half the length of the monopoly which you granted to the old subway."

Thus the McAdoo subways were established to the benefit of the people, and no one was injured because every avenue and opportunity of transportation which was open to the citizens before, is still open on the same terms, and if a person chooses to cross the river by ferry, he is still at liberty to do so; he is not forced to use the new means of transportation, and at the end of twenty-five years, which is less than that of the average life, these subways pass to the people, as owners, and may be leased to competing companies, who may then be able to transport the people at a greatly reduced price. So the distinction between these subway syndicates and the syndicate or trust which increases the price of the articles made, and closes the opportunities and avenues of industrial development, is very clearly marked.

In the city of Cleveland, we have three-cent railroad fare. A subway company is granted a franchise for a period of years, whereby they agree to bore into the earth and open up a new avenue of transportation for the people, and it is allowed under its franchise to charge five cents per capita for transportation within a certain zone, this being two cents in excess of the price charged by the surface lines. At the end of a certain period, the city has the right to take over these subways, at a predetermined price. In this case, the subway is charging two thirds more than the surface cars, but who is injured by this? Every avenue and opportunity of transportation which was open to the citizens before the advent of the subway, is still open to them. They are not forced to travel in the subway, as the surface cars are still running; they are not forced to pay the higher price unless they find it to be to their interest to do so. Unless they believe it to be to their interest to travel in the subway, at a greater speed, and pay the added toll of two cents, they are still free to use the street cars at three cents, to drive their own conveyance, or to walk if they please.

This latter illustration approaches in certain respects more nearly to that of the patent monopoly than any of the others, but there are other illustrations before we come to the patent monopoly. We will assume that there are two cities, say Philadelphia and Pittsburgh, separated from each other by many miles of distance, and by a chain of mountains which in the crude days of our forefathers were almost insurmountable barriers to transportation. To avoid these barriers, the first settlers who moved westward probably followed along the routes of the rivers and streams, and passed through the gaps in the mountains made by the water-courses. Finally roads were built along these easy paths of travel, but they were winding roads, and did not take the shortest distance between the two points. Roads were built by the southern route, and by the northern route. In many cases these were originally toll roads, and after a lapse of time became free to the use of the citizens. Now comes a man who says the time has arrived when a new road should be constructed between these points, in an air line. To do this he says, I must first make my survey, I must blaze my way through the forest, I must bridge the streams at great cost, I must fill the low spots, I must bore through the mountains in order to make easy grades. And he proposes to the State that he will, at his own cost and expense, build this line from point to point, provided he is permitted to make a charge, a toll charge, a royalty charge for the use of this road for the limited period of seventeen years, to reimburse himself for his thought, his time, his risk, his expense. At the end of this limited period the road becomes a public road from which he can draw no further revenue; for all time to come following this limited period it is free to the people of the State, and no man shall thereafter collect one penny of toll or royalty for use of this road. And the State grants him the franchise to do this thing, and does not stipulate what toll he shall charge, arguing, and very properly arguing, that he must charge a price so low as to induce people to use his straighter, flatter, better road, or otherwise they will use one of the other roads which had been established before. His self-interest would prompt him to do this. If he places his royalty too high, no one will use his road, for all other roads are still open for use. His self-interest will prompt him to put his price of toll or royalty so low as to attract trade to his new road. Who is injured by this new road? If the old roads are still toll roads, the owners may be injured, but they can only be injured if it is to the benefit of the people that they shall be injured and shall use the new road. Every road, every avenue of transportation, every opportunity in this line that was open to the people before the new road was built, is still open to them. Unless this new road is so much smoother, has so much easier grades, has so much flatter curves, is so much more inviting, is in such shape that a team of horses can haul a bigger load over it with less effort and less expense, including the royalty or toll cost, no one need use this road. In other words, unless this road is better, everything considered, than the old roads, it will not be used by a single traveler. This illustration is closer in its analogy to the patent monopoly than any of the others, but still there are important distinctions between this illustration of the good roads monopoly and the patent monopoly.

In the subway illustrations, as well as in the good road illustration, the company or individual who sought the monopoly, had of necessity to use something which was owned by the municipality, the State or the nation. In the first case, this was the earth under the streets in New York city; in the second case, it was the earth under the streets in New Jersey and in New York city, as well as the earth under the navigable river, through which the tubes were to run; in the third case,

it was the public lands of the State through which he was to build his road, and under these circumstances it was but proper that as the city, the State or the nation was contributing something to make his monopoly profitable, these respective political units should have some right to prescribe the conditions under which they were to part with their own monopoly to the earth under the streets, the earth under the river, the public lands of the State. In the subway illustrations, as well as in the good road illustration, it should be noted that there are certain important distinctions over the steel trust and the shoe trust illustrations. In these latter monopolies there is no time limit, and this is important, for all thrifty, civilized people act on the theory of foregoing something to-day, if thereby they may benefit themselves and their children for the future. Many, if not a majority of the active workers of to-day, endeavor to lay by something for a rainy day, for old age, for the education of their children, and stint and cramp themselves in their daily living, to the end that something may be saved for themselves and their descendants in the future. No such hope arises under the steel trust or the shoe trust illustrations, but such a hope exists in the illustrations of the subways and the good road. There, the monopoly is limited for a predetermined period, after which time, by foregoing their right to these subways and roads for the present, they have them built by other people's funds, and in the latter part of their life, or the lives of their descendants, these become free to all for all time.

In the steel trust and shoe trust illustrations, it might be well again to call attention to the great distinction that they close avenues and opportunities which before were open to the people. They monopolize their products so that all the people for all time pay them increased price for their products. In the subway and good road illustrations, the monopoly was not to the entire trade, not to the entire industry, but concentrated upon a *new* avenue or opportunity which was thus opened, either industrially or in a transportation way. All other avenues and opportunities, industrial and transportation, remained as free and open as they were before the new avenue was opened, and as soon as the subways were built, as soon as the new air line road was built, the *tendency* would be to reduce the price of the before known means of transportation, in order to prevent a large proportion, or perhaps all of the people from being diverted from the elevated roads and the surface roads to the subway, to the detriment of the owners' old avenues of communication. In the New York subway illustration, that has not occurred, and it may not occur in other similar lines. This is due to facts well known. A consolidation has been brought about between the surface lines, the elevated lines and the original subway lines, whereby they became merged into one general combination; but if we may go a step further in the good road illustration it might very well happen that if the old modes of communication, or some of them, were toll roads, and this new air line road was established, the old toll roads, in order to prevent a diversion of their traffic to the new and better road, might very likely have to reduce the toll which they had before charged, and this would inure to the benefit of the people who were using the roads between these two points.

Having considered these illustrations, we are now prepared understandingly to take up the question of the patent monopoly, which at this time, in view of the Supreme Court's decision in the case of Henry v. Dick, is of such interest to the people of this country.

The Constitution of the United States provides that "Congress has power to promote the progress of science and useful arts by securing for limited times to inventors, the exclusive right to their respective discoveries." (Constitution of the United States of America, Art. 1, Sec. 8.) And this constitutional provision was drawn for the purpose of stimulating inventors to invent, devise and discover new and better ways of doing things than had been known before, and to justify the investment of time and money required to develop them, with the idea that it would eventuate for the benefit of all the people.

This monopoly does not run forever, as in the steel trust and shoe trust illustration; it does not run for fifty years, as in the first subway illustration; it does not run for twenty-five years even, as in the McAdoo illustration. It is limited to but seventeen years. There is another distinction. In the subway illustrations and in the air line road illustration we have seen that the monopolizing company has used something which before belonged to the city, the State, or the nation. This is not true regarding the patent monopoly. Nothing that was in existence before, is utilized by the inventor; at least the patent monopoly does not prevent the utilization by the people of anything that was known before the invention as freely as though the invention was not conceived and perfected. The inventor does not take a piece of land and say, keep off of this for seventeen years, and if you do, I will do so and so. He merely conceives a new idea, and reduces that idea to practical use by incorporating it, as a usual thing, into a usable mechanical form that was never known or used or described in a printed publication before his conception of the invention; and this new thing, thus reduced to practical, usable form, subserving a useful purpose, he, under our law, is allowed the exclusive right to, for seventeen years. His right consists merely in the right to exclude others from the making, the using, the selling of this invention which he first reduces to practical form. This is monopoly in one respect only, and that is, touching the very thing, and that thing only, which he alone of all the world was the first to think of, and to reduce to practice.

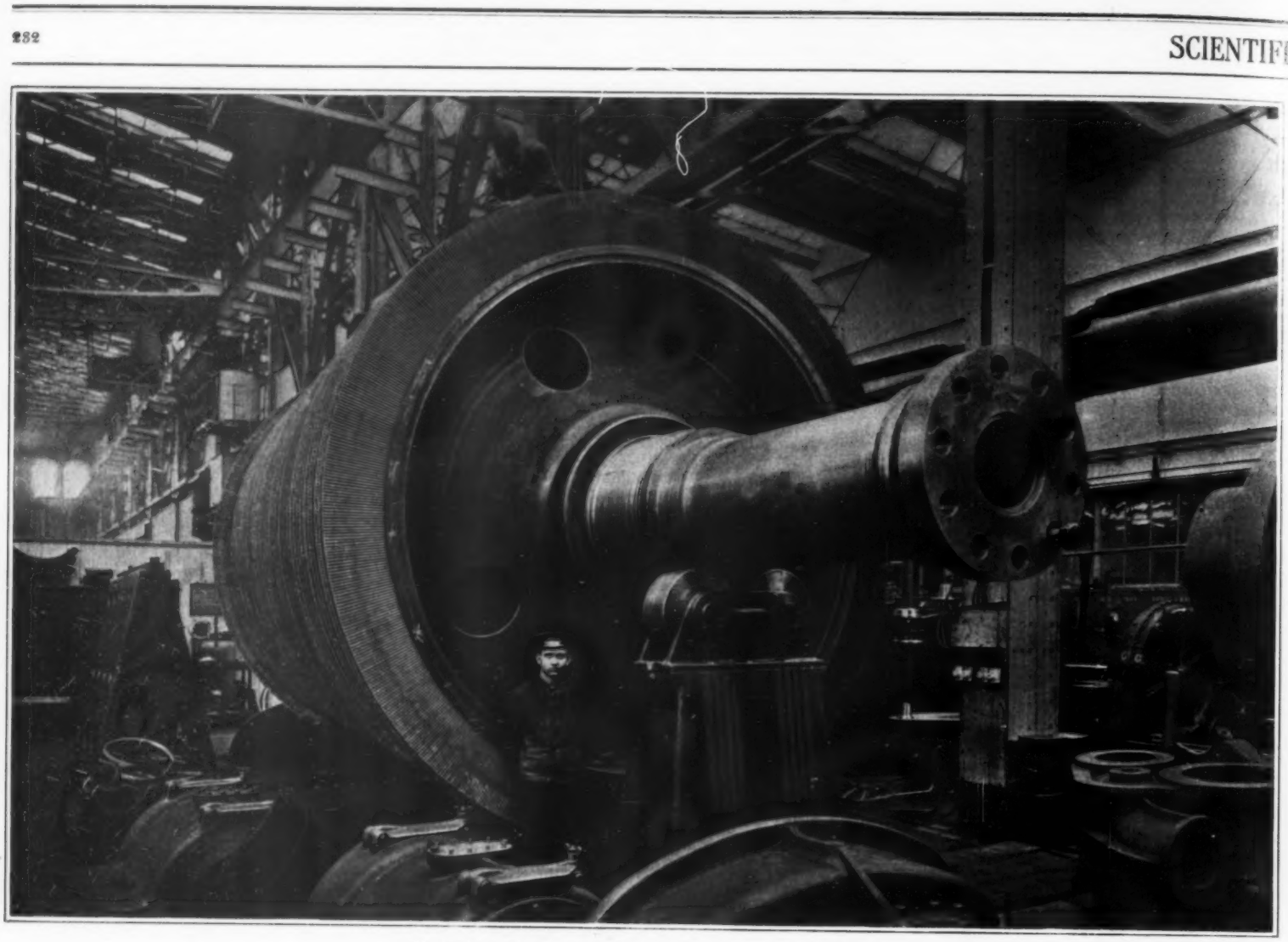
It should be further understood, that not everything that is new and useful, is patentable, and subject to the patent monopoly, for under our Statute, three things must occur before any man may have a patent on his invention: First, the thing must be new; second, it must be useful; third, it must involve invention. Even our august Supreme Court has never yet been able to formulate an affirmative rule by which to determine the presence or absence of invention in every case, but it has said that invention must be something more than the skill of the calling; it must be something more than would naturally occur to a skilled man in that calling; it must be something more than would naturally occur to the most skillful man in that calling; it must be something more than the skill of the mechanic; it must be something more than the highest skill in engineering; the inventor to have a patentable invention, must show forth the far-sightedness of the inventor as distinguished from what would ordinarily occur to a man who was skilled in his calling. It will thus be seen that the inventor, under our laws, should be treated in a more favorable way than the subway company was treated, and should be treated in a more favorable way than the air line good road man was treated. He does not utilize in his invention any part of the municipal, State or public domain, as was true in these illustrations. He merely conceives a new idea entirely out of the ordinary, something that would not naturally occur to the most skilled man in the calling in which he is inventing. He conceives an idea never before thought of. He reduces that to practical working shape. It must subserve a useful purpose, it must be a benefit to the community. He creates an entirely new avenue or industrial opportunity. He closes no old avenue or opportunity either in transportation or industry. All the avenues of industry and transportation which were known to the human race before his new thought was reduced to usable form, are still usable by the human race. He monopolizes nothing but the usable, incorporate form of his new idea. He then has a monopoly on this new idea, after he has complied with the terms of the law relating to obtaining the patent, for the limited period of but seventeen years. He is allowed to charge a toll or a royalty to any one who makes, who uses, or who sells this incorporated form of his new idea. Usually it takes him from five to ten years to make any money out of his invention, and at the end of seventeen years from the date of issue of the patent, the thing becomes public property for all the ages that are to follow. He must make his royalty so low as to induce people to purchase his new invention rather than the old things that it supplanted, or they will not purchase it; and in no case are they compelled to purchase it, for every way of accomplishing what he has accomplished, which was old at the date on which he conceived his invention, is still free to be used, and he cannot prevent any one from using these. Again, the cost of making or turning into mechanical form his invention, plus the royalty which he asks for it, must still be so much lower than the next best thing in the older art, as that people will find it to their advantage to use his new thing, or they will not use the new thing. It should always be remembered that they are at liberty to use all the old things at any time.

The minority of the Supreme Court who joined in the dissenting opinion, in the case of Henry v. Dick, uses the following illustration to support its contention that the patent monopoly has been carried too far: "Take a patented cooking utensil. The power is now recognized in the patentee to bind by contract one who buys the utensil, to use in connection with it no other food supply but that sold or made by the patentee" (66 L. Ed. 666), and it is further stated in the opinion that "It is a matter of common knowledge that the change has been frequently resorted to for the purpose of bringing numerous articles of common use within the monopoly of a patent, when otherwise they would not have been embraced therein, thereby tending to subject the whole of society to a widespread and irksome monopolistic control." (66 L. Ed. 667).

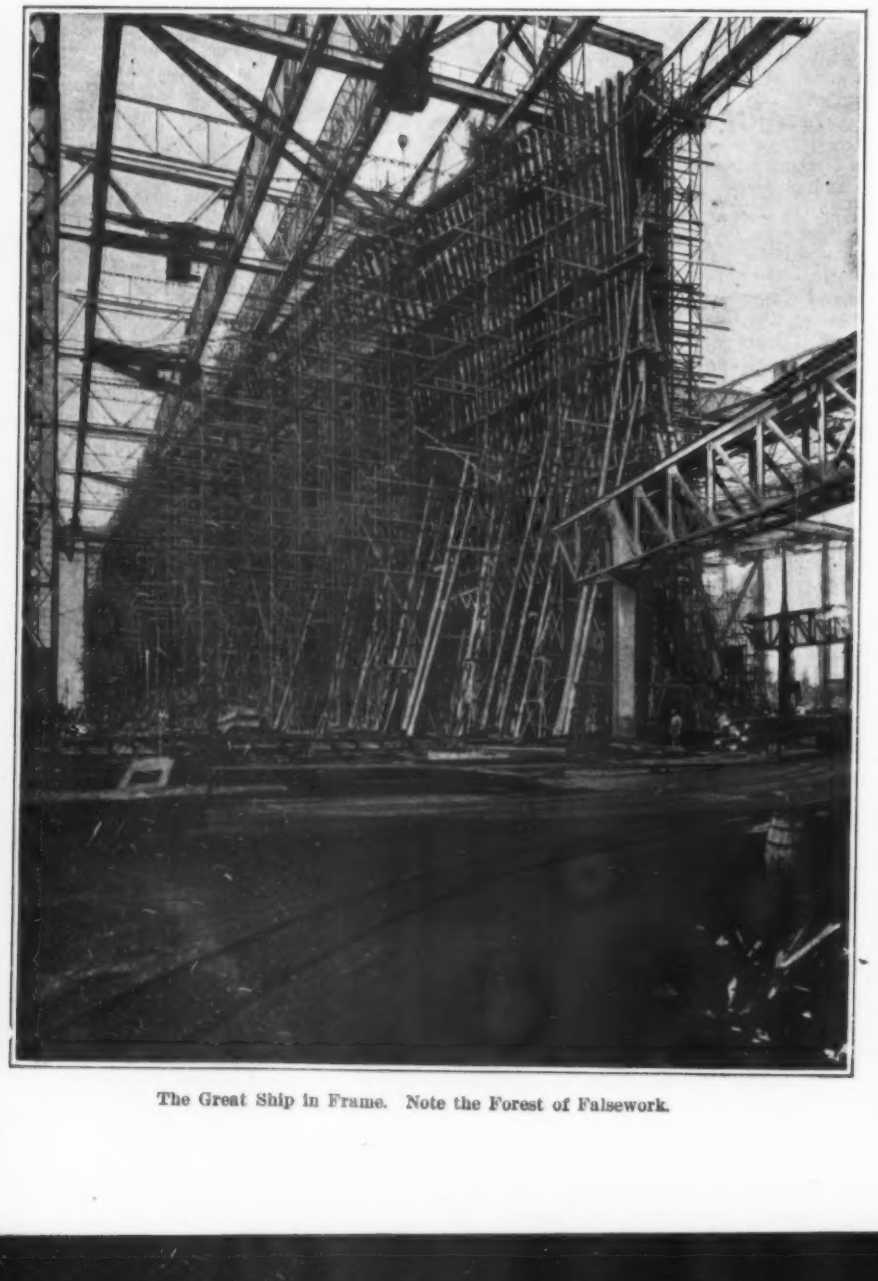
Let us carry this illustration still further, even to the limit if you please, and see what harm is to come of license conditions attached to the sale or use of patented articles. Let us assume the "cooking utensil" mentioned in the minority opinion, and let us say this is a cook stove which has one or more patented features in it. The owner of the patent makes the cook stove within the terms of his patent, within his exclusive or excluding monopoly right. When he leases or sells this cook stove, he stipulates with the buyer that the stove shall not be used, if you please, with any other kind of coal than the coal which comes out of his own mine; that no bread shall be baked in this stove except such bread as is made with flour which he makes in his own mills; that no salt shall be used in the bread, that no sugar shall be used in the cake, except the salt made and sold by himself, or the sugar made and sold by himself, or some company which he designates. What harm is done to any one by these conditions? There is no law to compel any one to buy or use this cook stove. It is not a monopoly such as a street railroad is, a monopoly which every one living within easy walking radius must use, or walk to his office or work. In the street railroad case, the average man must use the street railroad that is close to his house, and no other street car line may use that particular street to run street cars on. It is a monopoly to which he must pay tribute, whether he wishes to or not, and on the terms laid down by the railroad company as to fare, etc. In the cook stove case, he is not compelled to use this cook stove, with these so-called irksome conditions attached, unless he finds it to his interest so to do. There are hundreds of other cook stoves of different makes, which he can buy, without any conditions being attached to their use after he has once paid the price fixed by competition. Now, this new patented cook stove must be so much better than any one or all the cook stoves ever used before the advent of this stove, that the customer feels that it is to his advantage to buy this cook stove, at the higher price, if you please, and accept its use with all these so-called irksome conditions, and yet have the feeling that he is getting more for his money, by buying and using this cook stove, subject to these conditions, than he would get for the same money, if he bought a non-patented, competitive priced cook stove, and there are hundreds of cook stoves from which he may select. The owner of the patent does not dare to put a royalty price on this cook stove, nor a monopoly condition on the use of it, which will make any man hesitate even to buy this stove at the higher price, or under the irksome conditions, in preference to the old non-patented, competitive priced cook stove. Before this new invention in the cook stove line, no one had ever thought, no one had ever conceived of such an improvement, and it must be, to stand the fire of the courts, such an improvement as rises to the dignity of invention, as against the highest skill of the calling, the highest mechanical skill, and the highest engineering skill. In addition to all these, the excluding monopoly is limited to but seventeen years, and after that time, this invention, which is of such great value to the world as that purchasers are willing to pay a higher price and accept it under the so-called irksome conditions, then becomes for all the remaining ages public property from which no one may derive a further toll.

Instead of this patented cook stove being a monopoly, within the meaning of the steel monopoly, it is exactly the opposite, for it *introduces a new competitive cook stove into the markets of the world*, and thereby tends to reduce the price of other cook stoves upon the market.

The status of patent property has been well defined by Albert Walker in his textbook of patent law, and in closing I quote from it: "Patents are property, the owner of a patent is legally and equitably entitled to the same protection that the owner of any other species of property may enjoy. . . . . The right of property which an inventor has in his invention is excelled in point of dignity by no other property right whatever. It is equaled in point of dignity only by the rights which authors have in their copyrighted books. The inventor is not the pampered favorite of the Government or of the nation. The benefits which he confers are greater than those which he receives. He does not cringe at the feet of power, nor secure from authority an unbought privilege. He confers upon mankind a new means of lessening toil or of increasing comfort, and what he gives cannot be destroyed by use nor lost by misfortune. It is henceforth an indestructible heritage of prosperity. On the other hand, he receives from the Government nothing which cost the Government or the people a dollar or a sacrifice. He receives nothing but a contract which provides that for limited times he may exclusively enjoy his own. Compared with those who acquire property by gift or marriage, compared with those who acquire property by profits or sales or by interest on money, the man who acquires property in inventions, by creating things unknown before, occupies a position of superior dignity. Even the man who creates value by manual labor, though he rises in dignity above the heir, the dunce, the merchant, and the money lender, falls in dignity below the author and inventor."



The Rotor of the Intermediate Pressure (Forward) Turbine.



The Great Ship in Frame. Note the Forest of Falsework.

Launch of the Latest G

Some Details of the "Vaterland"

THE transatlantic liners, as they are successively launched from the British and German yards, show a steady growth in dimensions. As each century in the over-all length of these ships is passed, the prediction is confidently made that the limit has been reached, and length and breadth and tonnage must stay within the limits of the latest ocean giant.

In proof of this we have but to recall what was said and written when the "Campania," 625 feet long, was launched, or the "Deutschland," with her length of 665 feet, or the "Oceanic" (704 feet), the first ship to exceed 700 feet; or the "Lusitania," just 10 feet short of 800 feet in length; or the "Oceanic," with her stem to stern measurement of 882½ feet; or the "Imperator" (919 feet), the first ship to exceed 900 feet.

And now the "Vaterland" of the Hamburg-American Line, sister to the "Imperator," has taken the water, and in her the record for length is carried some 30 feet forward, the great ship measuring no less than 950 feet from stem head to after taffrail. In the "Vaterland," also, the beam is 100 feet, this being the first ship, merchant or naval, to reach that dimension.

She will be driven by quadruple turbine engines, and judging from the great size of the low-pressure turbine, as shown by the illustration, we imagine that her horse-power will be not less than 85,000 and her speed 25 knots—should her owners wish to drive her.

The third ship of the trio is already on the stocks, and she is to be even larger than the "Vaterland." Another 50 feet would render her the first 1,000-foot liner—and there is every likelihood that she will carry that distinction.

The "Imperator" leaves on her maiden voyage on May 24th next; and the "Vaterland" will be placed in service in the spring of 1914.

In her general construction the "Vaterland" closely resembles her sister ship, the "Imperator." Both ships have been built with an inner skin, forming a double hull which is carried high above the water line. These hulls are constructed of heavy steel plates of unusual strength. Some idea of the "Vaterland's" hull may be gained from the fact that more than 1,500,000 rivets weighing two pounds each have been u struction. As an additional precaution were riveted together and the walls o the port-holes were cut by a new pr the acetylene torch.

The "Vaterland," like the "Imperator," with searchlights of over 80,000 candle est ever constructed, which will be ca the foremast. These searchlights wil thirty miles at sea, and will enable the minate an object at a distance of sev the "Vaterland" and the "Imperator" a two crows' nests, the upper one being 1 level of the water, enabling the lookou jects many miles distant. She will b eighty-four life-boats which will acco board. Two of these life-boats will motor boats, capable of towing the oth boats are equipped with wireless app over a range of 200 miles.

These vessels will have the most co bulkheads and water-tight compartmen on any merchant ship. The bulkheads, longitudinal and transverse, are of exce The communicating doors throughout t trolled from the bridge. As a furthe compartments have been completely flo to test their efficiency under extreme view of the unusual number and s compartments, safety is more complet in ships of smaller dimensions.

The cabins of the "Vaterland" and " be the largest and most sumptuous of world. To assure maximum comfort the "Vaterland" will carry only a few than ships of half her tonnage. Her pu pare in size and richness of decoration rooms of the largest hotels of Europe several of these will be carried throu in order to raise the ceilings and lend tic spaciousness.

Special attention has been paid to

Riveting Stringer Plates by Hydraulic Power.

Latest Giant Steamship

"Vaterland" 950 Feet in Length

unds each have been used in her con- additional precaution the steel plates ether and the walls completed before ere cut by a new process employing ch.

," like the "Imperator," will be equipped of over 80,000 candle-power, the larg- ted, which will be carried high up on hese searchlights will be visible for n, and will enable the lookout to illu- at a distance of seven miles. Both nd the "Imperator" are supplied with the upper one being 170 feet above the r, enabling the lookout to discern ob- distant. She will be equipped with ats which will accommodate all on hese life-boats will be high-powered ble of towing the others. The motor d with wireless apparatus, working 00 miles.

ill have the most complete system of ter-tight compartments ever installed ship. The bulkheads, which are both ransverse, are of exceptional strength. g doors throughout the ships are con- bridge. As a further safeguard, the e been completely flooded with water iency under extreme conditions. In sual number and strength of these ety is more completely assured than r dimensions.

e "Vaterland" and "Imperator" will most sumptuous of any ships in the maximum comfort for all on board. ill carry only a few more passengers her tonnage. Her public cabins com- ciousness of decorations with the public st hotels of Europe or America; and ill be carried throughout two decks e ceilings and lend an effect of artis-

has been paid to the designing of the dining rooms on the new liner as well as to the entire commissary department. The main dining saloon, which extends the width of the ship, occupying two decks, will accommodate the maximum number of cabin passengers. In addition, there will be an elaborate Ritz-Carlton restaurant. To lend still further variety, there will be an elaborate grill room, a veranda café, palm garden and Vienna café.

The staterooms of the "Vaterland," like those of the "Imperator," will be unusually spacious. In order to produce a homelike appearance the berths have been removed and each room is furnished with an artistic brass bedstead. In each room will be found a marble washstand with running hot and cold water, large mirrors and luxurious chairs or couches.

A large proportion of the staterooms will have private bathrooms, there being more than 200 baths available in the first cabin alone. A surprising variety of special baths will be at the disposal of the passengers. There will be a sumptuous Roman bath with large swimming pool where sea bathing may be enjoyed, an elaborate Turkish bath with trained attendants, together with electric-light baths and special medicated baths.

The "Vaterland" will be equipped with large gymnasiums in the first and second cabins. These will be equipped with the mechanical Zander apparatus operated by skilled attendants. A running track and squash court is connected with the first cabin gymnasium. The decks are unusually spacious, affording ample opportunity for promenading and deck sports.

The section of the funnels which extends above the decks is sixty-nine feet in height, which would reach to the sixth story of an ordinary house. The largest locomotive in the world could pass through them, while a man standing beside one of them is completely dwarfed.

The rudder, again, weighs ninety tons, and the stock on which it swings weighs 110 tons, but it is so delicately balanced and controlled that it may be swung from side to side with a touch of the wheel on the bridge, nearly one fifth of a mile away.

Lifting the Starboard Propeller Shaft Into Place.

The Structure of the Atom—II*

The Physical and Chemical Properties of the Atom Explained in the Light of Modern Theory and Experiment

By Sir J. J. Thomson, F.R.S.

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 1944, page 219, April 5, 1913

On the last occasion I explained various processes by which it is possible to extract from atoms, whether belonging to a gas or to a solid, small particles which are negatively electrified. No matter what the source may be from which these particles are derived, they are absolutely identical, each carrying the same charge and possessing the same mass. These negatively electrified bodies having been removed from an object, whatever is left must necessarily be positively electrified, since it is impossible to generate electricity of the one kind without simultaneously liberating that of the other kind. An interesting question thus arises as to what is the nature of the positively electrified bodies left behind after the abstraction of the negative corpuscle. It has been shown that the latter are far smaller than any known atom, and it is conceivable that the positively electrified residue is also smaller than the atom. A few experiments suffice, however, to show that there is a great difference between the carriers of positive electricity and the negative corpuscles.

[This difference the speaker illustrated by means of a glass vessel consisting of two large bulbs united by a wide tube. In the latter was placed a perforated cathode. On turning on the current it was seen that the negative carriers above the cathode gave out a bluish-green glow, and where they struck the glass, produced a greenish phosphorescence. A small magnet if brought near the bulk would, it was shown, suffice to twist this negative discharge in any direction. The positive discharge, on the other hand, which was attracted down toward the perforated cathode and passed through it into the lower bulb, glowed with a reddish light, and where it impinged produced a bright red phosphorescence. A small magnet held near this lower bulb had apparently no effect whatever on the discharge. This showed, the lecturer stated, that the negative carrier was quite different in character from the positive ones. In another experiment Prof. Thomson caused a negative discharge to impinge upon some lithium chloride. The latter then phosphoresced with an intense steely blue color where struck, and it was stated that if this phosphorescence was observed through a spectroscope, the spectrum was a continuous one. Reversing the direction of the current, a corresponding stream of positively electrified particles was directed onto the lithium chloride. The phosphorescence was then red, and this, it was stated, gave a line spectrum showing the lithium lines.]

Experiments of this kind suffice to show that there is a very great difference between the negative and the positive carriers. Though the latter cannot be sensibly deflected by a small magnet, more intense fields give a measurable deflection, and by simultaneously subjecting this positive discharge to powerful magnetic and electric fields, it is possible to deduce, from the deflection produced by the joint action of the two, the mass of the positive particles. When this is done, no trace is found of any mass smaller than those of known atoms, the weights found coinciding, in fact, with the masses of the atoms and molecules which one would expect to find in the tube. The positive particles, therefore, are charged atoms and molecules, while the negative carriers are charged corpuscles, or, rather, corpuscles simply, since a corpuscle was essentially a negative charge. These corpuscles, moreover, are all identical, while there are as many different kinds of positive carriers as there are different kinds of atoms and molecules in the tube. This is well shown in Fig. 1, reproduced from a photograph obtained by bombarding a plate with positive carriers, after the latter have traversed a combined magnetic and electric field. Each curve on the plate corresponds to particles of a particular kind. The least deflected are the heaviest, the outermost curve corresponding to the atom of hydrogen, and the innermost to that of mercury; and there are, it will be seen, a number of curves on the plate. With the negative corpuscles, on the other hand, the photograph would consist of a single curve.

Curves, such as those in Fig. 1, give quite a lot of information about atoms, the mass of each of which can be determined by measuring the curves. Some of the curves are produced by charged atoms, while others turn out to be due to charged molecules, so that the photograph shows that atoms exist as well as molecules. With helium, however, only one curve is obtained, thus showing this gas to be monatomic. By using a sufficiently fine pencil of rays very sharp curves can be obtained, which afford definite proof that the atoms of any element have all exactly the same mass. If they had not, the curve obtained would be a blurred ribbon rather than a sharp line.

* The second of a course of lectures delivered at the Royal Institution, London, and reported in *Engineering*.

The fact that the positive particles have the same mass as the atoms and molecules in the tube shows that the process taking place in a discharge tube was the tearing out from an atom of one of the negative corpuscles, and that such corpuscles form accordingly constituents of every atom. It is important to know how many of these corpuscles there are in an atom. The facts already recited show that at least one can be torn out, but by studying the curves in the photograph it has been proved that from some atoms many more corpuscles can be removed. The carbon atom is found carrying both one charge and two charges of positive electricity, and at least two corpuscles can also be removed from the atom of oxygen, while from that of mercury as many as eight can be taken, and from krypton any number up to four or five. Heavy atoms, in short, can lose a considerable number of corpuscles, but the lighter atoms lost fewer, and from H I have not, so far, succeeded in abstracting more than one, this element being peculiarly economical in its expenditure of corpuscles. From oxygen and carbon not more than two corpuscles have been removed. In a later lecture I shall, however, bring forward reasons for believing that the number of corpuscles present is in each case equal to the atomic weight.

Fig. 1.

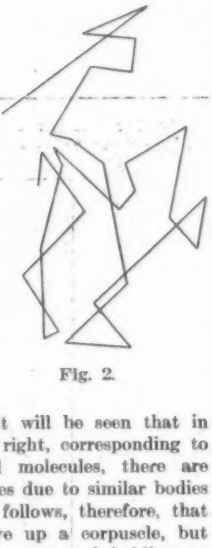


Fig. 2.

Referring again to Fig. 1, it will be seen that in addition to the curves on the right, corresponding to positively charged atoms and molecules, there are also traces, on the left, of curves due to similar bodies carrying negative charges. It follows, therefore, that the atoms can not merely give up a corpuscle, but they are also capable of picking up and holding on to these negative particles.

The process by which they acquire this negative charge is as follows:

The positively charged particle, after passing the opening in the cathode, enters a space in which the gases present have been broken up by the stream of particles, which ionizes the gas through which they pass, liberating negatively and positively charged bodies. The rapidly moving positive particle, after passing through the cathode, attracts one of the negative charges thus liberated, and becomes, accordingly, for the moment neutral. Not content with this, however, it attracts an additional negative charge, and thus gets deflected by the magnetic and electric fields to the left-hand side of Fig. 1.

Its affinity for this additional negative charge must be very considerable, as it is moving at the prodigious rate of about 50,000,000 centimeters per second, and has to pick up the negative charge as it rushes past. The attraction for this negative charge must therefore be very strong. It has been found that not all the gases, represented on the right-hand side of the photograph, are also represented on the negative side. This turns out to be very largely a matter of chemical constitution. Of all gases oxygen most readily picks up this additional negative charge (see illustration on page 269 of SUPPLEMENT No. 1921) and chlorine, another electro-negative gas, acts similarly. There are, however, other bodies, not usually classed as electro-negative, which are nevertheless represented on the left-hand side of the figure.

Hydrogen is one example and carbon another. In this connection it is of interest to note that if the carbon compound in the tube is "unsaturated," that is to say, if the carbon atom is bonded directly to another carbon atom, as in acetylene and ethylene, it is found represented on the negative side of the photograph, being then capable of picking up an additional negative charge. With saturated compounds, however, such as marsh gas, carbon is found only on the positive side of the photograph.

The photographs may also be used to determine if any elements not yet known are present in the tubes. At Cambridge we have thus found lines corresponding to a number of gases not yet recognized. The one of most interest has an atomic weight of 3. This line is very marked in a photograph taken when the gases driven out of platinum by bombarding it with the cathode rays form the subject of the experiment. It was found that, even after three days' bombardment, traces of this line could still be detected. Other metals, indeed, have been bombarded for a week without getting rid of this gas.

I shall next consider various ways of arriving at the size of the atom. This must obviously be very small, but both its weight and its size are now known accurately within about one per cent. One of the simplest methods in conception, though not in execution, is due to Perrin. The kinetic theory of gases shows that every particle present in a gas, at a stated temperature, contributes the same amount to the total pressure observed. Thus if N are the total number of molecules of a gas present in a given volume, then the total pressure exerted is equal to $N\,a$, where a depends only on the temperature of the gas. In other words, N being the number of particles, a is the average contribution of each to the pressure. It follows from the kinetic theory that a is the same whatever the nature of the particle in question, whether it is hydrogen, oxygen, mercury, or the heaviest that could be found. It will be evident therefore that if a were known, and also the pressure, the value of N could be found, this being the number of molecules in the mass under consideration.

How, then, can a be found? If the particles were so big that N could be counted, we could, by measuring the pressure, find a, which, as stated, is the same for all molecules. This, though somewhat crudely expressed, is practically what Perrin does. The first step necessary is to find something which, while constituted of comparatively big particles, behaves nevertheless like a gas, since the molecules of actual gases are far too minute to be visible even microscopically.

It has long been known that small particles suspended in a liquid are in a continuous state of agitation, the so-called Brownian movement. They dart hither and thither, being never at rest, but change their direction of motion abruptly, just as the molecules must do in a gas. Prof. Perrin has actually mapped out the paths followed by such a particle when observed for a small time, and this is reproduced in Fig. 2. It had early been suggested that the Brownian movements were equivalent to the molecular movements indicated by the kinetic theory. The small suspended particles behaved, in fact, in just the normal way that the molecule of a gas would do. This fact seemed to promise the possibility of getting something equivalent to gas with "molecules" big enough to observe and count, and this forms, so to speak, an artificial "gas," in which N could be counted and the corresponding pressure measured. The molecules of a gas are, however, all of the same size. Hence it was necessary to obtain a very fine powder as nearly uniform as possible to represent them. The most elaborate of Perrin's experiments were made with two powders, one being gamboge suspended in water, and the other mastic dissolved in alcohol and dropped into water. The powders thus obtained were not originally uniform, the particles being of different sizes, and as they stood they were quite unsuitable for the experiment contemplated. By laboriously "centrifugating" them for a period of over three weeks, Prof. Perrin finally obtained powders of extreme uniformity and great fineness. Assuming that these particles would behave like the molecules of a gas, he then proceeded to find N by actual count and to determine also the corresponding pressure. The particles were too fine to be directly visible in the microscope, but on submitting the liquid in which they were suspended to a very strong illumination, they appeared as bright specks, something like the particles of dust visible in a strong beam of light passing

through the air of an average room. By counting these specks it was possible to determine N, but the question next arose as to how the corresponding pressure was to be determined. This pressure was not that of the atmosphere nor anything like it.*

Everyone knows that the density of the air diminishes with the height above sea-level, the difference being equal to the weight of the intervening air. The same consideration applies to Perrin's emulsions. If placed in a long vertical column it is found, when the steady state is attained, that the density of the specks is much greater below than higher up. At the bottom the specks are crowded together, while at the top they are quite widely separated. At every layer of the column the pressure is equal to $N\,a$, N being the number in that layer. If a count is taken at two different levels, the number at one level is, say, N_1, and at the other N_2. The pressure difference is therefore $(N_1 - N_2)a$, and this must be equal to the weight of all the particles between the two levels. If r is the radius of a particle, its volume is $\frac{4\pi r^3}{3}$, and its weight in the suspending fluid is equal to $\frac{4\pi r^3}{3} \times g(\rho - \sigma)$, where ρ is the density of the particle and σ the density of the fluid. Hence, if N is the mean number in unit height, the weight in a thickness equal to t is

$$N \frac{4}{3} \pi r^3 g t (\rho - \sigma).$$

Hence we finally have the relation

$$a\,(N_1 - N_2) = N \frac{4}{3} \pi r^3 g t (\rho - \sigma).$$

Hence a can be found by counting N at different levels, and measuring the radius and density of the particles.

The method of counting N which would naturally occur to an experimenter would be to take photographs and count the specks. It was found, however, that this plan would not work, the plates being never sufficiently distinct. Had it been practicable to work in the way suggested, many months' labor would have been saved. Actually Prof. Perrin counted them, so to speak, "by hand," sitting at the microscope and making a record whenever he saw the flash of light, due to one of the specks crossing the field. By taking hundreds of observations he thus got by actual count a kind of average value of N at a number of different layers.

The next quantity to be determined was a, the radius of the particles. This is extremely small, being far too minute for measurement by the micrometer in the microscope. The measurement, therefore, was effected indirectly by observing the rate at which the particles subsided through liquids such as water. As explained in the first lecture, this rate depends on the size of the particle, and by measuring it the radius of the particles can be deduced by means of Stokes's law. The particles used by Perrin subsided extremely slowly; but by taking care that their motion was not disturbed by convection currents, the rate of fall can be found with great accuracy. This was one of the methods used by Perrin to determine the size of his particles.

He had next to justify his assumption that the particles in his emulsions behaved like the molecules of a gas. In the case of a gas a is the same whatever the gas might be; and Perrin, in repeating his experiments with different powders, found that in this case also a was the same whatever the powder used, getting identical results with gamboge and with mastic. Another check was obtained by showing that a was the same whatever the liquid used in forming the emulsion, and by these two searching checks he justified his assumption that the particles acted like the molecules of a gas.

(To be continued.)

* [On this point the following may be of assistance to some of our readers: If a gas be enclosed in a vessel it exerts a certain pressure on the sides. This pressure is due simply and solely to the impact of the molecules, which are darting hither and thither in a random fashion similar to that represented in Fig. 2 *supra*. Since none of Prof. Perrin's particles could escape from the surface of the liquid, his column of water formed in effect a closed vessel, which confined his artificial gas. The particles constituting the latter being in continuous motion were continuously coming into contact with the sides of the tube, and it is the pressure produced by their impact which corresponds to the pressure of the "gas" and which it was necessary to measure.—The Editor of *Engineering*.]

The Dangers of Street Traffic and Danger Signals

An Educational Campaign

By Frederick Remsen Hutton, M.E., Sc.D.

The American Museum of Safety in New York has been conducting a campaign of education among the school children, to bring home to them the common dangers of the home and their play-places. The gas-stove and the opened knife, at home; the trolley, the live wire, and the fast-moving or heavily-laden vehicle where they play, have all heir potential or present dangers to the child whose mind is on something of vastly greater interest for the moment. A semi-automatic sense of danger must be awakened in the city child, like an eighth sense, to turn his head in the direction from which danger is approaching; and on the other hand, traffic must follow defined paths, and use standard warning procedure.

This campaign is being backed and promoted by the Rapid Transit interests of Brooklyn, for they have a stake in making the streets safe both from a humanitarian and a business point of view; and the printing of leaflets and the provision of school lectures are the methods in use.

The city street is the playground of many children, both from necessity and from choice. It is the only open place under the sky in many parts, and it is the social center and the gathering place for playmates and for partners in the group games. The quick-moving, electric trolley car, with its relatively silent approach, has yet the safety attaching to a fixed path or track. The child can early learn to keep off the rails and the right of way, and when it does trespass, to look out for "the cars." But the free-moving vehicle has the use of the rest of the roadway in common with the pedestrian and the playing child. Both child and adult "on their lawful occasions" are there, and they must avoid meeting each other. What standards shall be established on both sides?

There are some absurd proposals that all individual vehicular traffic shall be stopped at intervals; this would defeat its own purpose, and be hardly enforceable, except in spots, and the whole subject is too broad to be discussed in its entirety in a short article. But there are certain standards which seem so possible for the user of the wheeled vehicle that it may be worth while to discuss them.

(1) *The Controlled Traffic.*—If all vehicles head one way, and only turn around at the corners, or street intersections, then all on foot need only look for danger from one direction. On the right of the center, you look over the left shoulder; on the left of the center, you look for danger from the right hand. No child should ever play in the intersections of streets, and no pedestrian or vehicle should ever "cut the corners."

(2) *The Classified Traffic.*—Since it is the Rule of the Road that the faster vehicle passes the slower on the right of the former and by turning to the left hand of the slower, the faster vehicles will always be in the center of the highway, or farther away from the sidewalks of the street. This is the first classification, and rightly makes the center of the street the more dangerous part. But a second classification is that of the ordinary and the preferred class of vehicle as respects the right of way. The hospital ambulance and the fire-service vehicles on their errands of life-saving or rescue of lives or property, are entitled to speed, and the center of the street. Pedestrians should get on the sidewalks, and vehicles of the lower classes should go to the right of the highway and stop there. No child should be or remain on the roadway when a fire or hospital vehicle is exercising its paramount right of way.

(3) *The Standard Type of Warning Signal.*—No vehicle should have or sound the warning signal of a superior class. The powerful gong rapidly sounded is the accepted signal for the ambulance in this part of the world, and the high-pitched steam whistle or siren or the swinging bell is the fire signal. For others to use the emergency standards is to lower the warning value of the real ones, and should be forbidden by ordinance. No man should cry "Wolf" like the shepherd in the fable, to get a right of way to which he is not entitled, else he breeds carelessness in the face of real need.

(4) *A Standard Quality of Warning Signal.*—A warning signal must not only impress sound waves on the drum of the ear, but it must reach the mind behind the ear, and cause volitional action. The action should be partly automatic, in the sense that action should follow the sense-impression quickly enough to escape accident, if it comes near. Hence it will be of the greatest value if the mind can be trained to recognize the signal of the fast-moving vehicle, and at the same time to judge the distance from which the sound proceeds. Most drivers are watching the roadway about 200 feet in front of the vehicle on the city streets, or at about one block away. He probably sounds his signal for the person on the street at about this same distance. Hence the signal should carry its alarm notice over that distance to even a deaf or a slow-moving person and against the wind and other noises of the street. It should impress the mind with the notion of the speed necessary to avoid impact. The warning signal should be of a quality not attaching to any other street noise; and it should be audible from such a distance, that the person warned should not jump with a nervous movement to avoid something which seems at his side before he knew that it was anywhere near him.

(5) *The Warning Signal Should Not be Sounded Unnecessarily.*—To do so is not only to make the street more noisy than necessary, but also it breeds the habit of disregarding the signal when it is full of real meaning. A noisy street is dangerous when the danger signals cannot be heard; the quieter the street the more easily is the attention caught.

(6) A true musical note (one with a definite number of air-waves per second) is not as serviceable for arousing attention and for warning as a pure noise, unless it is much louder in intensity than such noise. The so-called siren is a pure tone at all points of its range, but to make it carry sudden warning, it has to be so loud that it is rightly to be forbidden where noise is an objection. The short explosive note of the diaphragm types of signal, where a steel diaphragm is set vibrating by an electric motor on the principle of Savart, makes the first sound waves as effective as those which leave the signal later, and this is its best claim to be a safety device, in the sense that the American Museum of Safety uses that term. The common pneumatic reed actuated from a hand-bulb cannot be heard in noisy traffic or against strong winds for any considerable distance, or even a city block, and is scarcely, therefore, entitled to be classed among safety devices, in the Museum sense.

While it is safe to say that a standardization along the above lines will reduce the number of collisions on the streets, there still remains the irreducible minimum whose origins are carelessness and absence of mind.

Liquid Fuel*

The Cantor lectures, just concluded by Prof. Vivian B. Lewes on "Liquid Fuel," provide exactly the kind of information required at this moment to steady public opinion and to indicate the probable course of development of a vast industry. So far as Great Britain is concerned, the wider the fields of distribution are separated, the better it will be for naval, mercantile, and industrial purposes, and it is to be hoped that the sketch presented by Prof. Lewes, representing the extent and value of the fields thus far opened, will induce young engineers and geologists to take up the task of prospecting, surveying, and operating in new areas. There is need for discrimination in regard to the products of the respective oil fields so far discovered and worked, for it must not be assumed that they demand the same initial treatment in each instance. The crude oil of Burmah differs, for example, from that of Rumania, and both these products differ from that of Mexico. Hence, there is ample opportunity for young chemists to apply their knowledge and to seek their fortunes in some of the most attractive countries of the world. The quantities so far being won are impressively great, and the statement that in 1912 the total weight of crude oil taken from the oil fields was between forty and fifty million tons may to some minds suggest early finality; yet the experience of the world's coal fields, and of the unexpected discoveries that are made from time to time, affords ground for hope that such misgivings may be unwarranted. In Mexico, Peru, and elsewhere a considerable proportion of the available oil is used locally, and there is no doubt that the consequences of the improved supplies of fuel thus rendered available in such countries will be a cardinal factor in their future development. It is by optimists rather than by pessimists that success in the problem of the liquid fuel industry will be achieved.

* Reproduced from the Engineering Supplement of the London *Times*.

Experiments on Liquid Drops*

Ready Method for Making a Globe of Liquid Two Inches in Diameter

By Charles R. Darling

Before the advent of the nineteenth century, the number of liquids available for scientific investigation was limited to water, alcohol and other products of fermentation, naturally occurring oils, and a few obtained by chemical means. Now, thanks to the advances made in organic chemistry, the number of available liquids has been greatly increased; but although the chemical properties of the newer liquids are well known, very scanty attention has been paid to their physical properties. Hence the liquids used in the ensuing experiments, although familiar to the chemist, would probably be designated "rare" liquids by the physicist, because their constants do not appear in ordinary physical tables. The present article will be devoted to a description of some of the remarkable physical properties of certain organic liquids, which have been investigated by the writer during the past two years, more especially with regard to the formation of drops and spheres.

THE FORMATION OF DROPS AND SPHERES.

In order to produce a drop which may be made to enlarge to considerable dimensions, and to break at will, it is necessary to run the liquid used into water from a vessel controlled by a tap, and to employ a liquid only slightly denser than water at the prevailing temperature. After many trials, the author has found that the liquid *orthotoluidine* is in every way suitable for the purpose. As sold commercially, this liquid has a deep red color; is insoluble in water; and at 24 deg. Cent. has exactly the same density as water at 24 deg. Cent. Above this temperature orthotoluidine is lighter than water, while below 24 degrees it is heavier; and as the equidensity temperature is near to that of the atmosphere in a room, the experiment may be conducted with the minimum of trouble.

The apparatus requisite for the complete study of drops under control is extremely simple, and is sketched in Fig. 1. A funnel, furnished with a tap, and having the stem widened at the extremity to a diameter of three or four centimeters, is arranged so as just to touch the surface of water contained in a flat-sided glass vessel about 15 centimeters high, 12.5 centimeters wide, and 7.5 centimeters deep—exact dimensions being of no importance. The water in the vessel should be at a temperature of about 20 deg. Cent., and orthotoluidine allowed to flow in slowly from the tap. A large drop then gradually forms at the end of the stem of the funnel, and by closing the tap at any time the outline of the drop may be examined at leisure. Control ceases when the constricted neck becomes narrow, and the drop then slowly breaks away, a secondary drop, as usual, being formed from the neck itself. The accompanying Figs. 2 to 8 from photographs by the writer and Mr. B. Abel, show several stages in the formation of a drop of orthotoluidine, controlled as described. Figs. 7 and 8 are specially interesting as showing the recoil after the partition of the drop, both the portion clinging to the stem and the separated drop being flattened; and the secondary drop, which is seen elongated in Fig. 7, is seen to have recoiled in Fig. 8. An exposure of approximately one tenth of a second was given, the vessel being illuminated by an arc-lamp. It is easy, by this method, to obtain drops three or four centimeters in diameter, if the instructions given above be carefully followed.

An interesting modification of the experiment is the production of inverted or rising drops, which may be accomplished by bending the stem of the funnel into a parallel branch, as shown in Fig. 9. The widened end is then immersed in water at about 35 deg. Cent. to a depth of three inches, and the tap of the funnel opened so as to allow the orthotoluidine to flow slowly. As the liquid is warmed to a higher temperature than 24 deg. Cent. in passing through the stem, it becomes of less density than the surrounding water; and on escaping the drops, therefore, rise to the surface. The general shape of inverted drops resembles that of falling drops, the neck, as usual, giving rise to a secondary small drop.

The production of spheres of liquids demand equality of density between the liquid and its surroundings. Formerly, Plateau's method was followed, in which spheres of oil were formed in a mixture of alcohol and water brought by trial to the same density as the oil—a somewhat troublesome proceeding. By carrying out the following instructions, spheres of liquid, of any desired size, may easily be obtained: A flat-sided glass vessel, about eighteen centimeters (seven inches) high, is filled with water at 23 deg. Cent. to a height of about twelve centimeters. The correct temperature is secured by adding warm water to tap water and mixing until a thermometer shows 23 deg. Cent. By the aid of a pipette a five per cent solution of common salt in water is discharged at the bottom of the vessel, to a depth of about two centimeters, this layer preventing the sphere, when formed, from sinking to the bottom when the temperature falls. Orthotoluidine is now allowed to flow gradually into the water from a tube of one centimeter diameter, the end of which, to commence with, is placed about two centimeters distant from the surface of the layer of salt solution, but is afterward raised gently as the sphere grows in size. In this way spheres two hundred cubic centimeters or more in volume may be formed; and, by raising the delivery tube rapidly, the attached sphere may be separated, and will remain floating in the liquid.

The photographs shown in Figs. 9 and 10 illustrate the mode of formation and the appearance of the detached sphere. In the experiment depicted the orthotoluidine was run from a burette, with a view to measuring the volume of the sphere, which in this case was one hundred cubic centimeters.

Prof. C. V. Boys, F.R.S., has suggested a modification of the procedure which dispenses with the necessity of warming the water. After placing the layer of five per cent salt solution at the bottom of the vessel, the pipette is again filled, and the salt solution discharged, in diminishing quantities, from the bottom layer upward to within about two centimeters of the surface. The orthotoluidine is then allowed to flow into the center of the vessel from a tube bent so as to discharge laterally; and the sphere formed will then float or sink until it finds a layer equal in density, in which it will remain at rest. It is necessary, in this case, to exercise care in grading the density of the water from bottom to top by discharging the salt solution slowly, and gradually raising the pipette.

It may be mentioned here that certain other liquids may be used instead of orthotoluidine; for example, anisol produces spheres when run into water at 15 deg. Cent. But the beautiful color of orthotoluidine, combined with its insolubility in water, and the absence of other objectionable features, renders this liquid more suitable than any other, either for producing controlled drops or spheres. It is, moreover, relatively a cheap liquid, and should be welcomed by all who are interested in this fascinating branch of physics, as it enables phenomena, formerly difficult and troublesome to observe, to be demonstrated in the simplest manner.

* Reproduced from *Knowledge*.

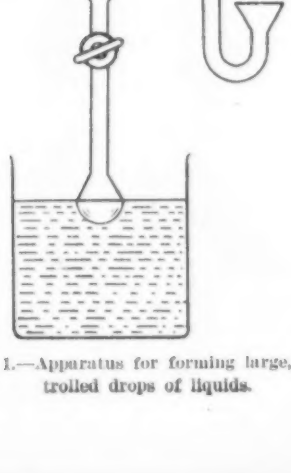


Fig. 1.—Apparatus for forming large, controlled drops of liquids.

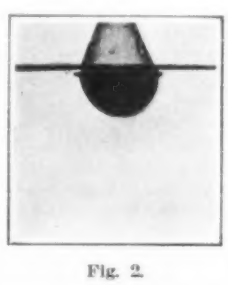


Fig. 2.

Fig. 3.

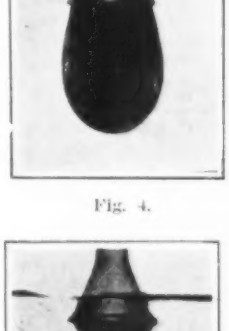


Fig. 4.

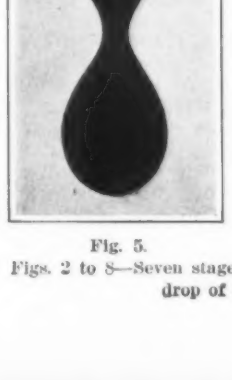


Fig. 5.

Fig. 6.

Fig. 7.

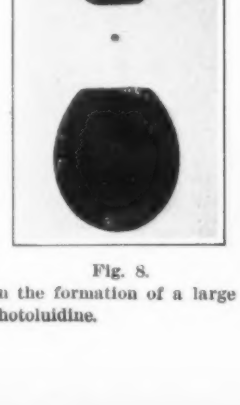


Fig. 8.

Figs. 2 to 8—Seven stages in the formation of a large drop of orthotoluidine.

Patents and Monopolies

An inventor may conceive no new mechanical movement, for broadly no new mechanical movement has been discovered or produced for many years. He may use old mechanical principles, but he puts them into new combinations which produce new and useful results to the benefit of the world. He makes something out of nothing as nearly as it is possible for this to be true. He does not utilize in his invention anything which he has to take away from other people, or deprive them of the use of anything they before enjoyed, such as the land under the streets, in the subway illustration, the earth under the river, the public lands, etc. He conceives an entirely new combination of mechanical elements. Each one of these particular elements may have been old, but the idea of combining them into one new, unitary operative machine for a useful purpose, is new. Under these circumstances he should not be hampered and restricted as other monopolists should be, but should receive the fullest protection that the state can give him.

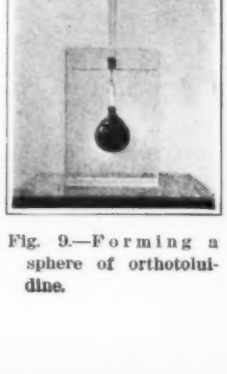


Fig. 9.—Forming a sphere of orthotoluidine.

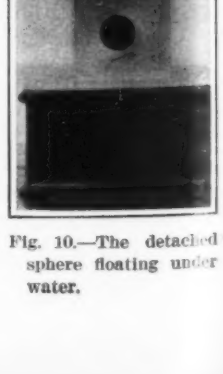


Fig. 10.—The detached sphere floating under water.

Plow and Harrow Preparing Ground for Sowing of Beets.

Planting Sugar Beets—Sowing the Seed.

The Sugar Beet in its Relation to Other Crops*

How European Farmers Have Multiplied Their Harvests

By Truman G. Palmer

UNTIL recently, outside of scientific agricultural circles, it was a generally accepted conclusion in the United States that sugar-beet culture injured the soil. Farmers so contended, and so universal was the contention that factory managements were compelled to concede that the farmers were right. Certain it was that after having been planted to beets several successive seasons, fields yielded a lower tonnage with each succeeding year.

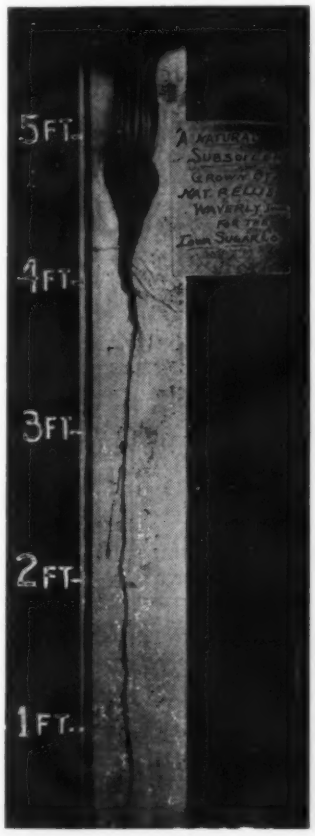
While the Department of Agriculture pointed out many advantages of sugar-beet culture and urged farmers to engage in it, various agricultural weeklies advised their readers that whatever might be the tonnage per acre and whatever the price of beets per ton, they could not afford to engage in beet culture as it soon would destroy the productivity of their fields and ruin the value of their farms.

Some ten years ago I read in a country weekly the first detailed statement I had seen which purported to show in bushels per acre just how much sugar-beet culture increased the yield of other crops when grown in rotation with them. The article gave with much particularity the result of a series of experiments which it was claimed had been conducted in Germany, and showed that sugar-beet culture greatly improved the soil. Although unsigned, it bore evidence of sincerity and I republished it in a short history of the beet-sugar industry, only to be met with expressions of incredulity.

Feeling that we in the United States might have failed to discover the magnet which induced the nations of Europe to favor the beet-sugar industry to a far greater extent than they favored other industries, I went there to study conditions at first hand and to verify or disprove the statement contained in the country weekly above noted. I searched for reports of recent experiments on the subject, but was told that there were none; that the facts had been definitely determined many years ago and that there was no more occasion for making such experiments now than to make a resurvey of the distance between Berlin and Vienna—both had been determined beyond question; even the trade press had ceased to give space to it; for decades every European agriculturist had recognized sugar-beet culture as the father of modern scientific agriculture, the keystone to the arch.

It thus became necessary to search for the works of earlier authors. In these works and in conversation with agricultural economists and sugar-beet growers, I discovered the cause of all our trouble, the one reason why the experience of American sugar-beet farmers gave contrary results to those obtained throughout the sugar-beet districts of Europe. American farmers were growing beets on the same soil, year after year, their only thought being "so many tons of beets per acre at so much per ton," whereas, since learning of the indirect value of sugar-beet culture, European farmers use them as a means to increase the yield of other crops rather than for their direct money value, and in order to spread the benefits over as great an area as possible they plant beets on the same soil but one year in three to five. From time to time, this information since has been placed before American sugar-beet farmers, and now, by practical experience, many have learned of the value of sugar-beet rotation and are enthusiastic over the results obtained.

If announcement were made that an Edison or a Burbank had discovered a means whereby each acre in the United States which is devoted to cereal crops could be made to yield two bushels where they now yield but one, regardless of any reasonable expense which might be involved, the discoverer would be greeted as the world's greatest public benefactor, the one who solved the problem of the high cost of living.



A Sugar Beet.

Showing the long tap-root and laterals by which it opens up new depths of fertility and improves the quality of the land.

The value of the telephone, the electric light and many other important inventions sinks into insignificance when compared to that of a discovery which enables a country to feed double the number of people which could be fed before its utilization. Such a discovery was made a century ago and was heralded and utilized by the leading nations of Europe, with the result that their worn-out soils have been so rejuvenated that now they produce two bushels of grain where formerly they produced but one. But for the fact that Europe learned to rotate her cereal crops with a hoed root crop and thereby doubled her acreage yield of cereals, European nations still would be encouraging and assisting emigration because of inability to feed their increasing population.

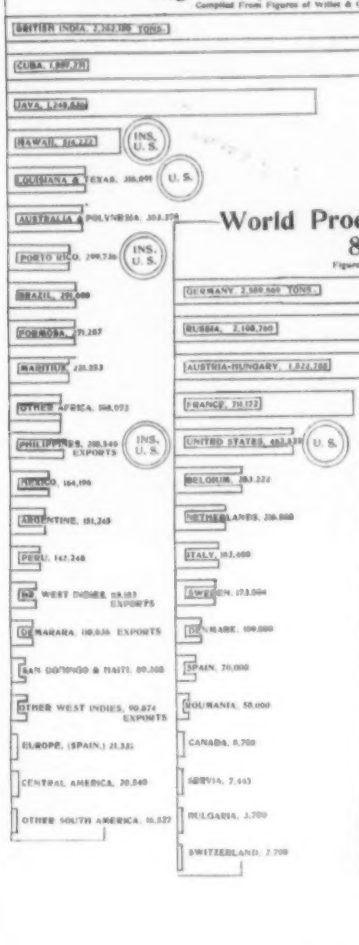
Strange as it may seem, this important discovery has not been exploited in the United States. With few exceptions American writers on agricultural topics seem to have been totally oblivious both as to the cause and of the fact that the "worn-out soils of Europe" have been so built up that they now produce two bushels of grain where the virgin soils of the United States produce but one. In their ignorance, some American writers even advise our farmers against adopting the very method which has revolutionized agriculture in Europe. And so it follows that American farmers have not profited by it and their yields per acre remain practically stationary, while the crop yields of the balance of the world increase from year to year. During the past thirty years the combined average yield per acre of wheat, rye, barley, and oats in the United States has increased but 6.6 per cent, while the acreage yield of the same crops in Germany has increased 80 per cent during the same period.

Experience in the United States and throughout Europe demonstrates conclusively that the introduction of a hoed root crop in the rotation one year in four is a prerequisite to heavy yields of cereal crops. Even though a farmer applies no science to his work save that of devoting his fields to a root crop one year in four, he will reap more bushels per acre of all cereal crops than will the farmer who avails himself of all known scientific agricultural knowledge but fails to introduce a hoed root crop in his cycle of rotation.

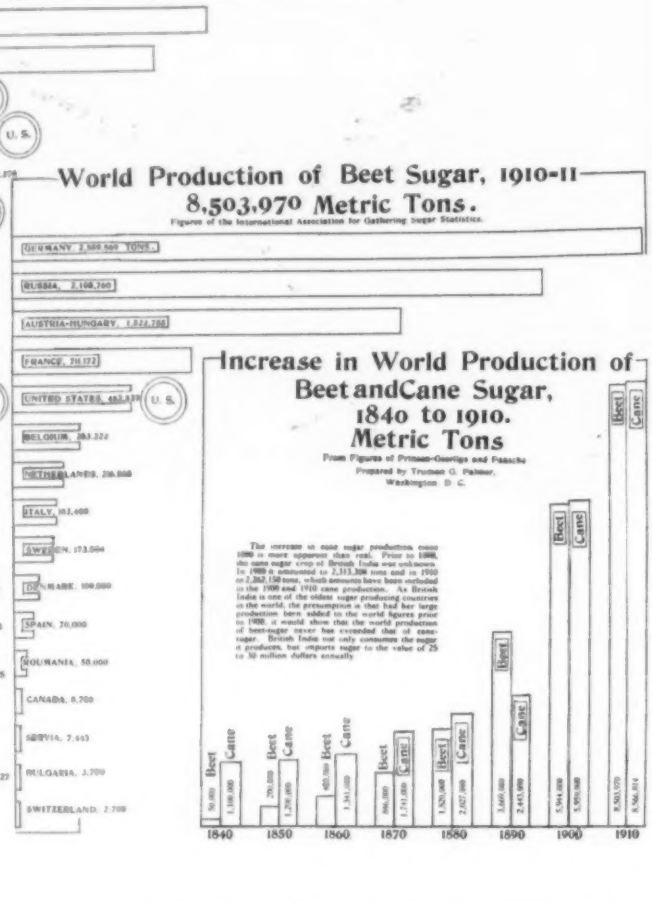
While the writings of Cato and Pliny and other ancient agricultural writers indicate that the art of root crop rotation was practised 2,000 years ago, Great Britain has the distinction of being the first country in modern times to introduce root culture in rotation with cereal crops as a means of increasing the yield of the latter. For a hundred years the basis of British agriculture has been the turnip. In 1805, Thaer, the English agriculturist, wrote a book on the subject of root crop rotation with cereal crops, and as a result of his teachings and of those who followed him, British farmers increased their plantings of roots from year to year. They now grow 2,000,000 acres of hoed roots, principally turnips, in rotation with 6,500,000 acres of cereal

* Reproduced from Senate Document No. 890.

World Production of Cane Sugar, 1910-11
8,566,814 Metric Tons.
Compiled From Figures of Willet & Gray.



World Production of Beet Sugar, 1910-11
8,503,970 Metric Tons.
Figures of the International Association for Gathering Sugar Statistics.



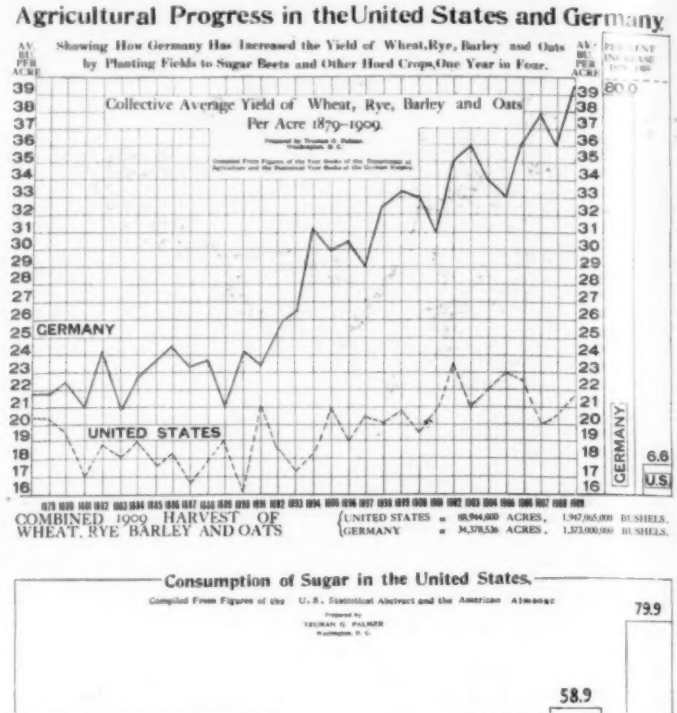
Increase in World Production of Beet and Cane Sugar, 1840 to 1910. Metric Tons

From Figures of Prinsen-Geerligs and Paasche
Prepared by Truman G. Palmer, Washington D. C.

The increase in cane sugar production since 1890 is more apparent than real. Prior to 1898, the cane sugar crop of British India was unknown. In 1903 it amounted to 2,313,306 tons and in 1910 to 2,262,150 tons, which amounts have been included in the 1908 and 1910 cane production. As British India is one of the oldest sugar producing countries in the world, the presumption is that had her large production been added to the world figures prior to 1900, it would show that the world production of beet-sugar never has exceeded that of cane-sugar. British India not only consumes the sugar it produces, but imports sugar to the value of 25 to 30 million dollars annually.

Agricultural Progress in the United States and Germany

Showing How Germany Has Increased the Yield of Wheat, Rye, Barley and Oats by Planting Fields to Sugar Beets and Other Hoed Crops, One Year in Four.



COMBINED 1909 HARVEST OF WHEAT, RYE BARLEY AND OATS

UNITED STATES	=	88,944,000 ACRES,	1,947,965,000 BUSHELS.
GERMANY	=	34,378,536 ACRES,	1,373,000,000 BUSHELS.

Consumption of Sugar in the United States.

Compiled From Figures of the U. S. Statistical Abstract and the American Almanac
Prepared by TRUMAN G. PALMER, Washington, D. C.

Includes all sugar, whether for direct consumption or for manufacturing purposes. Purchases for direct consumption in 1901, 268.5 lbs. per family, or 53.7 lbs. per capita.

Sources of European and United States Sugar Supply.

Prepared by Truman G. Palmer. From Figures of the International Association for Gathering Sugar Statistics. F. O. Licht, Willet & Gray, British Board of Trade and other Government Figures.

CONTINENT OF EUROPE.

Germany. Consumption, 1,577,059 Tons Domestic Beet Sugar. Surplus for Export, 1,125,888 Tons.

Russia. Consumption, 1,338,780 Tons Domestic Beet Sugar. Surplus for Export, 148,885 Tons.

France. Consumption, 760,791 Tons, of which, Domestic Beet Sugar, 609,111 Tons; French Colonial Sugars, 138,709 Tons; Foreign Cane, 18,971 Tons. Surplus Beet Sugar for Export, 169,236 Tons.

Austria-Hungary. Consumption, 663,879 Tons Domestic Beet Sugar. Surplus for Export, 811,535 Tons.

BELGIUM.(a)

NETHERLANDS(b)

Balance of Continental Europe. Consumption, 908,132 Tons Domestic Beet Sugar.

(a) Belgium, Consumption, 129,098 Tons Domestic Beet Sugar. Surplus for Export, 155,444 Tons.

(b) Netherlands, Consumption, 112,694 Tons, of which 8,702 Tons from Java; Balance Domestic Beet Sugar. Surplus for Export, 145,724 Tons.

UNITED STATES.

Louisiana & Texas, 292,099 Tons.

Domestic Beet Sugar, 514,963 Tons.

From Hawaii, 489,974 Tons Free of Duty

From Porto Rico, 236,138 Tons Free of Duty

From Philippines 171,112 Tons Free of Duty

From Cuba, 1,431,866 tons at 20% tariff reduction

Other Foreign, 392,259 Tons, Full Duty

(1) Maple and Molasses Sugar, 17,182 Tons

UNITED KINGDOM.

From British Colonies 127,760 Tons.

Foreign Cane, 481,110 Tons

From Germany, 499,980 Tons.

From Austria-Hungary 311,131 Tons

France, 67,431

Other Beet 294,670 Tons.

160,667 Tons.

1910-11 WORLD SUGAR CROP:

	Metric Tons
Cane	8,566,814
Beet	8,503,970
Total	17,070,784

Sugar Consumption of the World

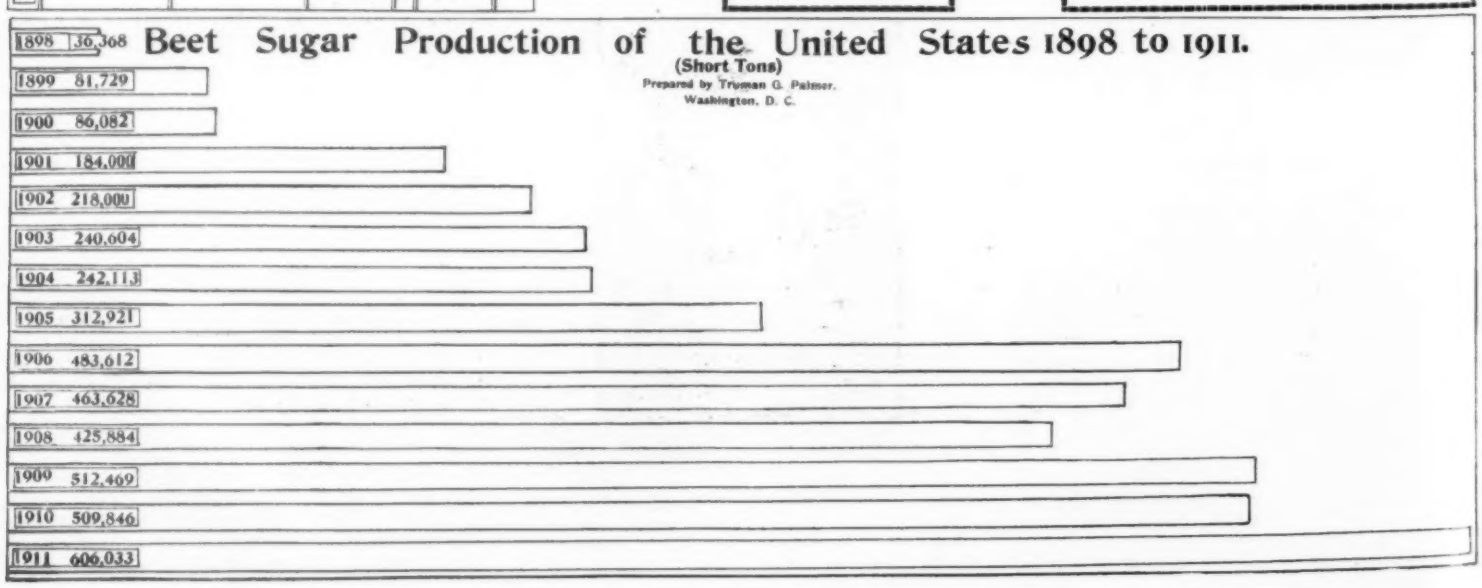
(In Metric Tons)

	Tons
United States, Domestic Beet, Cane and Maple	824,844
United States, Insular Cane, Free of Duty	947,214
United States, Total Domestic and Insular	1,772,058
United States, Foreign Cane and Beet	1,634,147
United States, Domestic and Foreign	3,406,205
United Kingdom	1,999,513
Continental Europe	5,300,431
British India	2,974,506
Balance of the World	3,490,129

Beet Sugar Production of the United States 1898 to 1911.

(Short Tons)

Prepared by Truman G. Palmer, Washington, D. C.



crops, which accounts for their heavy yield per acre. Thaer's work was translated and placed in the hands of German farmers, and for many years German agricultural economists endeavored to induce them to adopt Thaer's methods, but in vain. The objections defeated all attempts in this direction. First, it required deep plowing, and deep plowing meant that a new crop of stones would be turned up each year to be hauled off the fields. Second, it meant the introduction of a crop which in itself possessed but little money value, had to be fed instead of sold, and was even less profitable than the crops which they already were growing. They declined to grow it.

A few years later, Napoleon's scientists discovered the indirect value of sugar beets when grown in rotation with cereal crops, and on March 18th, 1811, the Emperor dictated a note to his Minister of the Interior, instructing him to see that 90,000 acres of beets were planted in the different arrondissements the following season, and that the proper officials be appointed to enforce his command. He then appropriated 1,000,000 francs with which to establish schools of instruction and to be given in bonuses to those who erected factories. Although it was a new and unknown crop, the farmers were compelled to plant the beets. At the end of two years, 343 small French factories were producing 7,700,000 pounds of sugar and by 1836 the French sugar product amounted to 40,000 tons while that of Germany amounted to but 1,400 tons.

Observing that sugar beets in France revolutionized agriculture by increasing the yield of cereals to an even greater extent than had turnips in England, German economists used every effort to induce their farmers to plant sugar beets. As they had failed to induce their farmers to grow turnips, so did they fail to induce them to grow sugar beets. Finally, they concluded to follow the French plan, and by government aid enable the factories to pay such prices for beets as would coax the farmers to increase their meager plantings. They levied a high rate of duty on imported sugar, and established a system of government bounties on sugar exports, whereby their sugar manufacturers not only were enabled to pay high prices for beets, but to sell their sugar in foreign markets at a price below the cost of production and still make a handsome profit. Immediately, the German sugar industry began to expand and other European nations adopted similar fiscal systems concerning their sugar industry, with the result that to-day one half of the world's sugar supply is derived from European sugar beets.

When sugar-beet culture was introduced into Europe, their farmers were practising what is known as the "three crop system" of rotation—three successive cereal crops, followed by one year of fallowing, the fallowing in order to rest the soil and to enable them to pull out the dense growth of weeds by hand. It is stated that in Germany, approximately one third of the total area of level land was regarded as being too poor to pay for cultivation, and their yield of cereal crops on the better lands was but 12 bushels per acre.

They were plowing but three to four inches deep, using fertilizers sparingly, and the fertility of the thin layer of loose surface soil all but was exhausted. The grain roots were unable to penetrate the hard soil underneath, and could they have done so, it would have been of no avail, for, containing no humus and not having been aerated, it was not fertile. Being a deep-rooter, a prerequisite to ideal sugar-beet culture is that the soil be stirred to a depth of eight to fourteen inches.

The tender beetlet having to undergo the shock of thinning as soon as it comes up, in order to leave only one beet in a place, demanded a well-prepared, mellow seed-bed. Gathering the sugar in its leaves from the atmosphere by the aid of the light and storing it up in the root, the sugar beet would not thrive if the light were cut off through being shaded by weeds, and the eradication of the weeds before going to seed meant not only further stirring of the soil by cultivation and hoeing, but weedless fields for succeeding crops.

Being plowed out in the autumn gave an extra fall plowing, which left the land in condition to absorb instead of shed the fall and winter rains, storing up the moisture for the following season's crops.

With the removal of the main root, myriads of fibrous roots were broken off and left in the soil to an estimated average of a ton to the acre, and in rotting, they not only deposited humus in the lower strata of the soil, but they left minute channels through which it became aerated, and hence fertile. The roots of subsequent crops followed these interstices and drew nutriment from two and three times the depth of soil formerly reached, and hence the farmers doubled or trebled their soil without increasing their acreage.

Utilizing the by-products for stock feeding purposes greatly increased the stock-carrying capacity of the farms, thereby furnishing a proportionate increase in the quantity of barn-yard manure with which to build up the productivity of the worn-out soil. Although many American farmers still fail to recognize the value of barn-yard manure and consider it a nuisance, inasmuch as the accumulations must be removed, scientists yet have to discover its equal as a fertilizer. The application of this increased quantity of the best fertilizer known, and of other fertilizers, not only resulted in a greatly increased tonnage of beets, but as the beets absorbed only a portion of the fertilizing elements, the balance was available for the crops which followed during the succeeding three years.

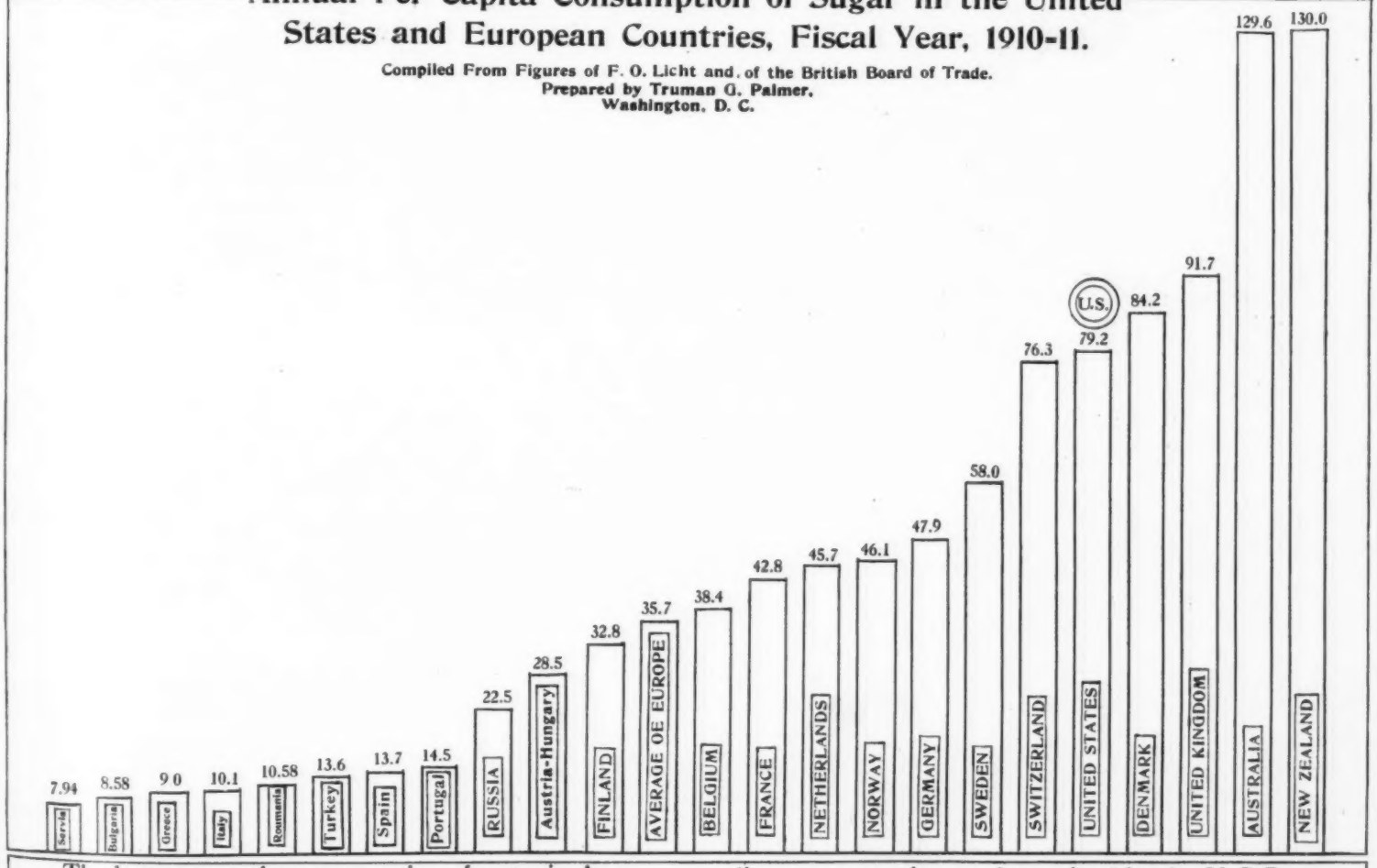
The reason why the culture of sugar beets improves the soil to a greater extent than does the culture of other root crops is because their culture insures more liberal fertilization, deeper plowing and better cultivation than ordinarily is given to other root crops and because of the greater amount of fibrous roots which are left in the ground.

Farmers will engage in sugar-beet culture in preference to the culture of other root crops because it is a cash money crop, while other crops only can be fed to stock, and because after having been sold for the sugar contained in the beets, farmers haul back to their farms the by-products which contain all the elements extracted from the soil, and the feeding value is but slightly diminished by the extraction of the sugar.

The culture of sugar-beets in Europe taught them the advantage of having a hoed root crop in the rotation, and now in the districts where there are no sugar factories, they raise sugar beets, mangolds, swedes and turnips for stock-feeding purposes, as do also the Brit-

Annual Per Capita Consumption of Sugar in the United States and European Countries, Fiscal Year, 1910-11.

Compiled From Figures of F. O. Licht and of the British Board of Trade.
Prepared by Truman G. Palmer.
Washington, D. C.



The large per capita consumption of sugar in Australia and New Zealand is not due to the cheapness of the product, the average retail price as reported by the British Board of Trade being six cents per pound.

Of the 79.2 pounds annual per capita consumption of sugar in the United States, 53.7 pounds or 268.5 pounds per family, is purchased by consumers for direct consumption, as determined by the U. S. Bureau of Labor in 1901. The remaining 25.5 pounds is purchased by manufacturers for use in confectionery, condensed milk, biscuits, chewing gum and other manufactured products, the prices of which are not affected by the price of the sugar they contain.

ish farmers, but American farmers can not be induced to grow a hoed root crop, except where a sugar factory is at hand to contract for the product at a high price.

As a result of sugar-beet culture, the areas of Europe which formerly were regarded as worthless have been brought under cultivation, thus greatly increasing the cultivated area, the three-crop system of rotation with one year of fallow has disappeared, and the fields now yield four crops in four years instead of three crops in four years.

Where formerly only the better lands would yield 12 bushels of cereals three years in four, or 9 bushels yearly per acre, now with all the poor land added to the cultivated area, the worn-out and the worthless soils have been so rejuvenated that the present combined average yield of wheat, rye, oats and barley in western Europe, including the yield of the less progressive States of the south, is 27.2 bushels per acre, while in Denmark it is 36.3, in Germany 39.4, in Holland 41.9, and in Belgium 51.9 bushels, as compared to an average yield of but 21.6 bushels of the same crops from the virgin soils of the United States.

In the farming districts of the United States where sugar-beet culture has been introduced, the yield of cereal crops grown in rotation with sugar beets is greatly in excess of the yield in Western Europe, or even in Germany. In 1909, from 200,000,000 acres devoted to corn, wheat, rye, oats, and barley in the United States, crops were produced to the value of $3,000,000,000. Had this area produced as many bushels per acre of each crop as were produced in rotation with sugar beets by the sugar-beet farmers reporting to me, at the same price per bushel their yield would have returned them $6,900,000,000, an increase of $3,900,000,000. That American farmers generally can and will secure such yields if the beet-sugar industry spreads, is certain, and the inevitable result will be a lowering of prices of food commodities, thus dividing the advantage between producers and consumers and materially reducing the high cost of living.

It cost Germany and other European countries large sums of money to develop their indigenous sugar industry, but their extra production of grain and stock, and the consequent influence on the price of meats and dairy and cereal products, has repaid them many times.

From 1840 to 1903, when European export bounties were abolished under the terms of the Brussels Convention which was brought about by Great Britain, the German government paid its sugar manufacturers $351,000,000 in export bounties, and so well satisfied were they with the results obtained, that the figures were published in chart form, bearing the legend, "Please Hang in a Conspicuous Place," and sent broadcast through the Empire. During a period of 63 years it perhaps has cost the German people as much in protective duties as it cost in export bounties, a total of say $700,000,000, but this entire amount is more than repaid each year in the increase of cereals and live stock.

Since adopting this fiscal policy, Germany has produced 54,000,000 tons of sugar, valued at $4,720,000,000, of which there has been exported 26,000,000 tons, which has drawn from the balance of the world $2,500,000,000, and Germany now exports sugar to the value of $50,000,000 a year. Having become the greatest sugar producer of the world, Germany, more than any other country, dominates the world price of sugar. The result of European beet-sugar production which, as stated before, now constitutes one half of the world's supply, has so lowered the price of sugar that based on Magdeburg quotations, the present annual sugar requirements of the German Empire cost the German people $200,000,000 less than the same amount of sugar could have been purchased for in 1855, thus constituting a saving which in itself repays every four years the entire expense of establishing the industry.

The results of the opposite agrarian policies which have been in constant operation in Germany and Great Britain during the past three quarters of a century are worthy of consideration by the American people, who consume one fifth of all the sugar produced in the world.

About the time that Germany began to foster her beet sugar industry, Great Britain was in the throes of debate concerning the abolition of the duties on imports of cereal crops and the adoption of Cobden's free trade policy. At Manchester, in October, 1843, at a public meeting called for the purpose of expounding his theories to the people, Mr. Cobden said:

"I have never been one who believed that the repeal of the corn laws would throw an acre of land out of cultivation. . . . Our object is not to diminish the demand for labor in the agricultural districts, but I verily believe, if the principles of free trade were fairly carried out, they would give just as much stimulus to the demand for labor in the agricultural as in the manufacturing districts."

Five years later, Cobden's theory was adopted and the "corn laws" were abolished. Grain, vegetables, meat and other farm products were transferred from the dutiable to the free list and the British free trade policy was inaugurated.

But Cobden did not prove to be a prophet. In 1841, of the 16,000,000 people of England and Wales, 2,333,000 were engaged in agricultural pursuits, while in 1901, of their 32,500,000 people, but 998,000 were engaged in agricultural pursuits. During the past thirty years, 3,000,000 acres of land have been withdrawn from tillage to cereal crops and laid down to grass, and during the same period, land values, which have doubled and even quadrupled in Germany, have decreased $5,000,000,000 in the United Kingdom, as stated by R. H. Inglis Palgrave, F.R.S., in the *Journal* of the Royal Statistical Society for March, 1905:

"I have now to sum up the total loss of agriculture during the last 30 years, and will begin with the loss in the capital value. With respect to this, the final report of the commission on agriculture, printed in 1898, records a decline of nearly £1,000,000,000 sterling in the capital value of land in the United Kingdom as having occurred between 1875 and 1894."

While Germany has extended her tilled area and has increased the yield per acre 80 per cent in 30 years, Mr. Palgrave gives the loss in value of crops produced in the United Kingdom during thirty years as $8,000,000,000. He says:

"We have now to attempt to sum up the drop in the value of agricultural produce in the United Kingdom from 1877 onward. I have endeavored to estimate it, as mentioned above, by taking the difference between the value of the produce each year from 1878 onward, and the amount of £255,000,000 estimated by Mr. Turnbull as the average value from 1872 to 1877. This difference amounts in all to £1,647,500,000."

Meanwhile, not having built up a domestic sugar industry, Great Britain has continued to import sugar, largely from Germany, which country, with its export bounties, was able to and glad to sell her surplus sugar at a price below the cost of production, because of the beneficent effect of beet culture on the yield of other crops. While Germany produced nearly $5,000,000,000 worth of sugar from 1840 to 1909, from 1846 to date Great Britain has imported $5,200,000,000 worth of sugar, a large portion of it coming from Germany, and she now imports sugar to the value of $120,000,000 a year, although producing experimentally richer beets and more beets to the acre than are produced in Germany.

Eliminating the taxation for revenue purposes in both countries, the German people procure their sugar at the cost of German production, plus a profit to German manufacturers, plus a brokerage to German brokers, while the people of the United Kingdom pay the German sugar manufacturers the cost of production, plus the German manufacturers' profit, plus German freight to the seaboard, plus German brokerage, plus ocean freight, plus insurance, plus brokerage in the United Kingdom.

That Great Britain is beginning to see the folly of her course, is indicated by the fact that the acreage has been secured, and a beet sugar factory is nearing completion near Yarmouth which will begin making sugar in a few months.

Vitality of Stored Seeds

THE old stories of seeds from which plants have been grown after hundreds of years of storage are now generally discredited. It used to be asserted that a variety of wheat, known as mummy wheat, began to a few stalks raised from seed found in the hand of an Egyptian mummy. Something of the sort seems to have been done, but there is much doubt whether the original grains were as old as the hand that held them, for the rascally Arabs along the Nile are not above trickery. Whatever may have been the truth, the announced results of experiments long conducted by the Royal Agricultural Society of Great Britain show that there has been error somewhere in the legends.

It was proposed to test, through as long a period as the matter required, the length of time in which carefully protected seeds of grains and fodder plants would preserve their power of germination when offered favorable conditions. Samples of forty-three kinds of farm seeds were procured in 1895, and have been since stored in paper bags kept in close, dry cabinet drawers. Tests indicated that the germinating power of barley and wheat was little affected during the first five years, but decreased rapidly until the tenth year, when no live seeds remained. Five years later white oats showed no life, but black oats germinated for fifteen years, owing, it is thought, to the adherence of the glumes. In the case of grasses, all the samples died between the eighth and thirteenth years. The various kinds differed somewhat, timothy proving strongest on the whole; but grass seeds showed great individual difference, some samples of each kind losing germinating power long before the others, although apparently just as perfect and vigorous. The clovers showed a slight loss of vitality during the first three or four years, a rapid loss for about four years more, and finally the gradual loss of the last 10 per cent during the following three or four years. The hardiest seeds of alfalfa lasted nearly fourteen years. Of the vegetables, most kinds lost vitality rapidly, and none of their seeds responded to cultivation after the eleventh year.

One rather curious bit of by-knowledge was learned during the course of the experiments, namely, the "living embryos transferred to the food-store of dead seeds utilize it freely, and that the store of food retains all its properties for years after the seed is dead."—*The Independent.*

Evaporation and Recondensation of Sea Water

A CALCULATION has been made of the time that elapses before a drop of water evaporated on the surface returns to the ocean. The total volume of water brought annually to the sea is 1/3460 of the total contents of the ocean. A particle of water before evaporation has stayed in the ocean on an average 3,460 years. Once evaporated the drop becomes condensed in about ten days and is then speedily drawn back to its ancient home.—*Science Conspectus.*

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